Guidance Note for Data Collection

Technical Assistance for Resilience to Climate Variability in the Building Sector of Antigua and Barbuda

Submitted to

Climate Technology Centre and Network
United Nations Industrial Development Organization

By

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A. Building Inspection Form Guide

The Building Inspection Form template is attached to this document. A Building Inspection Form should be completed for each of the 30 buildings selected under the technical assistance.

The form is organized into the following sections

- Building and Inspection Data – collects data about the building and inspectors
- Construction Data - collects data about building materials and components
- Condition Assessment Data – collects data about the condition and safety of structural elements and non-structural components including architectural components, sewage system, storm drainage, water supply system, electrical system and HVAC (including hot water).

  Safety ratings are Low, Average and High.

  Condition ratings are Good, Fair, Poor and Very Poor. If elements, systems, components etc. are evaluated as being in Very Poor condition, select Poor and explain why element, system, component etc. is in Very Poor condition.

The Categories sheet provides the list of options included in drop-down menus used in the Inspection Form.

B. Visual Inspection Guidance

Items of inspection that apply to various common structural systems and materials include:

1.0 Steel construction

Deterioration and damage that would be visible on steel members and connections

- corrosion,
- deformation,
- cracks and
- weld defects.

Make a qualitative assessment of the degree of corrosion. Useful categories to indicate the degree of corrosion are

- Minor: Surface corrosion that has resulted in negligible loss of section. It is useful to identify this condition so that preventative measures can be taken to prevent further corrosion.
- Moderate: Corrosion that has resulted in a measurable loss of section. Structural repairs may not be needed, but maintenance is definitely needed to arrest further corrosion.
- Severe: Corrosion that has resulted in a significant loss of section, to a degree that repairs probably will be needed. An example would be a beam whose flange has been reduced to a knife edge.

Signs of distress and other conditions that may be visible on members include:

- Excessive deflection
- Severe stress concentrations, as evidenced by cracking paint
- Cracks at notches, web penetrations, or coped areas
- Kinks from thermal strain
- Web crippling at bearings and locations of concentrated loads
- Diagonal web buckling near supports on built-up plate girders
- Bowing
- Misalignment
- Deformation
- Twisting of flexural members, possibly indicating insufficient lateral torsional bracing
- Presence/absence of bridging or other lateral bracing and its anchorage

Conditions that may be visible on connections include

- Cracks in welds
- Weld undercut
- Obviously undersized or missing welds
- Irregular welds
- Loose, broken, or missing bolts or rivets
- Bolt threads not fully engaged
- Bolt holes irregularly spaced or shaped
- Gaps between faying surfaces
- Evidence of slippage
- Inadequate edge distance of bolt holes
- Prying of clip angles
- Deformations
- Evidence of movement at bearing plates and sliding connections

2.0 Concrete Construction

Visible conditions that should be noted include

a) *Cracks* - Report the crack width either in numerical terms or, if there are many cracks, in categories. A simple and useful categorizing scheme is

- Hairline: Barely visible
- Fine: 0.8 mm [1/32 in.] to 1.6 mm [1/16 in.]
- Medium: Between 1.6 mm [1/16 in.] and 3 mm [1/8 in.]

- Wide: Greater than 3 mm [1/8 in.]

b) *Scaling* - Scaling is the flaking or loss of material from a concrete surface. Scaling is best characterized according to depth. For example:

- Light: less than 6 mm [¼ in.] deep
- Medium: Between 6 mm [¼ in.] and 12 mm [½ in.] deep
- Heavy: Deeper than 12 mm [½ in.]

c) *Spalling* - Spalling is the detachment of concrete fragments. Spalling is often caused by expansive forces generated by the corrosion of embedded reinforcement, but it can also be caused by other factors. Spalls are best categorized by size:

- Small: less than 150 mm [6 in.] in diameter
- Medium: Between 150 mm – 300 mm [6 in. - 12 in.] in diameter
- Large: Larger than 300 mm [12 in.] diameter

d) *Exposed reinforcement* - In areas of spalled concrete, the reinforced bars often will be exposed. The degree of corrosion should be noted and reported. In addition, the depth of concrete cover over the bars may provide useful information regarding the cause of the corrosion and may affect repair recommendations.

e) *Signs of water penetration* - Usually manifested as efflorescence, a whitish deposit of minerals, along cracks and joints. If the efflorescence is stained a rust colour, it probably indicates corrosion activity.

f) *Delamination* - Delaminations are incipient interconnected spalls usually extending over larger areas. They can be difficult to detect visually but are detected readily by sounding. If delamination is suspected, then a systematic sounding survey and mapping may be warranted. This is covered later in the "Testing" section of this chapter. Depending on the visual observations and their evaluation, it may be desirable to perform testing. Basic concrete testing also covered later in this chapter, and Chapter 15 describes the entire spectrum of concrete testing.

3.0 Wood Construction

The following signs of deterioration should be investigated during inspections:

a) *Checks and splits.*

A *check* is a radial separation usually wedge-shaped that occurs across the rings of annual growth. Checks are normally the result of seasoning, or drying shrinkage.

A *split* is a longitudinal separation along the grain, usually through the opposite surface, and is caused most often by stress or mechanical damage. Depending on their length and location in a member, checks and splits can diminish the strength of a member drastically.

b) *Insect damage* – Visually characterised by holes, frass and powder posting. The presence of insects such as termites and carpenter ants could also indicate the presence of decay. Insects can hollow out wood members. Wood shavings at entry holes are tell-tale signs of insect activity but may not be indicative of the full extent and severity of internal damage. If this type of damage is suspected, further investigation may be required.

c) *Alterations* – these can weaken members and should be noted in the inspection form. Alterations include those such as cuts in wood members to make room for plumbing.

d) *Decay* - Fungi in an environment with the proper temperature, oxygen, and moisture can consume and destroy wood. Wood moisture content needs to be above 20% to sustain fungal growth. Therefore, wood in a conditioned space and not subject to leakage or other unusual moisture would be unaffected by decay.

e) *Impact damage* - Impact by vehicles or equipment can cause serious immediate damage to wood structures.

f) *Staining or discolouration* – Stains or discolouration suggest that the wood has been exposed to water and may have a high moisture content which would be suitable to support decay. Rust stains from connections are also signs of wetting.

4.0 Masonry Construction

The majority of conditions/signs of distress usually encountered in masonry construction include

a) *Cracking* - movement with the masonry construction results in cracking

- Tapering crack in roughly the vertical plan usually means that rotation is being or has been, experienced as a result of subsidence.
- Parallel crack suggests movement is of constant magnitude along the length or height, which could indicate a tension or compression failure.
- Stepped cracks are usually the result of a shearing movement.

b) *Bowing or bulging of walls* – usually as a result of either thrust being applied to them (e.g. as a result of roof spread) or a lack of restraint.

- Bowing – outward swelling, or protuberance of a portion of a masonry assemblage
- Bulging – outward swelling, bowing or protuberance of a portion of a masonry assemblage from a vertical plane

c) *Spalling* – a condition of masonry in which the outer layer or layers of masonry units begin to break off (unevenly) or peel away in parallel layers from the larger block of masonry. Often an indication of overstress of the masonry unit

d) *Chipping* – a condition of small pieces of larger fragments of masonry units separating from the unit resulting from excessive stress

C. Photographs

1. When taking photographs, provide a general view of the condition and a detailed close-up of the condition of the element, component, system etc. being inspected.
2. Individuals conducting the visual inspection should ensure that photographs include a scale to indicate dimensions.
3. Photographs should be named so that they can be correlated with the Building Inspection Form.

D. References

The following resources were used to prepare the visual inspection guidance section:

a) ACI 201.1R-08 Guide for Conducting a Visual Inspection of Concrete in Service, American Concrete Institute - 2008

b) Guideline for Structural Condition Assessment of Existing Buildings, American Engineers - American Society of Civil Engineers - 2014

c) Structural condition assessment: for serviceability, rehabilitation, retrofitting, adaptive reuse, code compliance, and vulnerability

d) Wood and timber condition assessment manual, Robert White-Robert Ross - United States Department of Agriculture, Forest Service, Forest Products Laboratory - 2014