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President
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Dear Sirs

PROPOSED ENHANCEMENTS TO PERIODIC STRUCTURAL INSPECTION

BCA has reviewed the periodic structural inspection process and will be introducing some new measures to further raise the quality and value of such inspections.

Reference to Structural Layout Plans

2. With effect from 1 Nov 03, Notices of Inspection issued to building owners will require those where BCA has a record of plans, to furnish a set of structural layout plans for their engineers' use during inspection. The building owner need not purchase a fresh set of plans from BCA if he already has a record of it. Structural engineers carrying out inspection of such buildings are to make use of the structural layout plans to:

- understand the structural systems and layout of the building, so as to better identify critical areas for inspection;
- identify the allowable imposed load, so as to assess the usage and possibility of overloading; and
- assist in verifying if unauthorised addition and alteration works have been carried out in the building.

3. For buildings where BCA has no record of plans, structural engineers would have to exercise more professional discretion in assessing the structural system of these buildings visually. However, should the structural engineer be able to obtain a set of structural layout plans from the owner's records, he should make use of these plans and inform BCA as such.

SINGAPORE QUALITY CLASS

ISO 9001

Identifying Heavy Suspended Fixtures in Public Assembly Areas

4. From a survey of past building incidents that had affected public safety, it was found that a number were due to collapse of false ceilings. Though the structural engineer's main responsibility whilst conducting periodic structural inspections is to identify signs of defect, deformation or deterioration in the structure of a building, BCA would like to include the identification of potential safety hazards as an added value to the inspection process. BCA would like structural engineers to assist in the following during their visual inspection:

- to identify heavy false ceilings which are constructed of non-lightweight materials such as thick cement plaster, large cement-based or gypsum board;
- to identify heavy ceilings that are over high-density public assembly areas where members of the public would be present for a substantial length of time, such as waiting/ seating areas, food centres; and
- to inform the owner to carry out regular maintenance checks on the condition of these ceilings.

5. BCA will liaise with the Commisioner of Buildings, who administers the Building and Common Property Act, on the necessary follow-up actions.

Guidelines cum Checklist

6. In addition to the enhancements introduced, BCA is issuing a set of guidelines cum checklist to guide structural engineers in carrying out visual inspections. Over the years, BCA has come across many good practices by structural engineers and this is a useful way to share lessons learnt for the benefit of all. The guidelines addresses amongst other things, the scope of inspection and format for reporting, whilst the checklist helps draw the structural engineer's attention to critical areas or conditions in the building. A copy of the guidelines is attached for distribution to your members.

7. We would appreciate it if you could inform your members of the contents of this letter.

8. Please contact me if you require any clarification. Thank you.

Yours faithfully

YVONNE SOH
SENIOR MANAGER
ENFORCEMENT AND STRUCTURAL INSPECTION DEPARTMENT
for COMMISSIONER OF BUILDING CONTROL

Building and Construction Authority

PERIODIC STRUCTURAL INSPECTION OF EXISTING BUILDINGS

GUIDELINES

FOR

STRUCTURAL ENGINEERS

Nov 2003

CONTENTS

GENERAL

1 Background

1.1 The periodic structural inspection of existing buildings was introduced with the promulgation of the Building Control Act in 1989. Requirements governing periodic structural inspection of existing buildings are stipulated in Part V of the Building Control Act and the Building Control (Inspection of Buildings) Regulations.

1.2 The periodic structural inspection applies to all existing buildings except:
a) detached houses, semi-detached houses, terraced or linked houses which are used solely as places of residence; and
b) temporary buildings.

1.3 Periodic structural inspections are carried out based on the following frequency:
a) every 10 years for buildings where at least 90% of its floor area is used solely for residential purposes; and
b) every 5 years for all other buildings.

1.4 The inspection consists of one or both of the following stages:
Stage 1: visual inspection.
Stage 2: full structural investigation.

2 Qualifications and Expectations of Structural Engineers

2.1 There is a common misconception that a periodic structural inspection involves only a "visual" record of the observations during a brief tour of the building. Such misconception has to be corrected. The Building Control Act requires the visual inspection to be conducted by a structural engineer who must be a registered professional engineer in the civil or structural engineering discipline, rather than any other person. It is so because of the need for and importance of professional assessment and judgement in structural engineering during the visual inspection. Any other lesser assessment would provide little more than what a lay person could have observed from a casual inspection.

2.2 The structural engineer who is appointed by the building owner is therefore expected to carry out a comprehensive visual inspection that relies largely on his professional engineering assessment, judgement and advice. He shall exercise reasonable diligence and take active and personal interest in the planning and carrying out of the inspection of the building. A situation where he does not visit the building or totally delegates the inspection work to his

assistant or another person who is not a registered professional engineer in the civil and structural discipline is not an acceptable practice.

STAGE 1 : VISUAL INSPECTION

3 Scope of Visual Inspection

3.1 Prior to the commencement of visual inspection, the structural engineer is to obtain a set of the building's structural layout plans from the building owner. The availability of the structural layout plan will help the structural engineer to:

(a) understand the structural system and layout of the building;
(b) identify critical areas for inspection;
(c) identify the allowable imposed loads, in order to assess the usage and possibility of overloading; and
(d) verify if unauthorised addition or alteration works that affect the structure of the building have been carried out.

3.2 In general, the structural engineer is expected to carry out, with reasonable diligence, a visual inspection of:

a) the condition of the structure of the building
   - to identify the types of structural defects
   - to identify any signs of structural distress and deformation
   - to identify any signs of material deterioration

b) the loading on the structure of the building
   - to identify any change of use, misuse and abuse which can result in overloading

c) any addition or alteration works affecting the structure of the building
   - to identify any addition or alteration works which can result in overloading or adverse effects on the structure.

3.3 If there are no signs of any structural deterioration or defects, the visual inspection should suffice and unless the structural engineer otherwise advises, no further action needs to be taken.

3.4 If, on the other hand, signs of significant structural deterioration or defects are present, the structural engineer should make a professional assessment of the deterioration or defect and recommend appropriate actions to be taken. Such actions may involve repair works or full structural investigation to parts or whole of the building.

4 Limitations of Visual Inspection

4.1 There could be some difficulties in the conduct of a visual inspection as some of the main structural elements in a building may have been covered up by architectural finishes. It is therefore important that professional judgement is exercised by the structural engineer to determine which areas that are covered up should be exposed for inspection. Reference to structural layout plans to determine the presence of critical structural elements would be crucial under such circumstances.

4.2 Notwithstanding these difficulties, an inspection by an experienced structural engineer who exercises reasonable diligence would not be entirely fruitless or futile.

5 Coverage of Visual Inspection

5.1 Structural engineers and building owners often question the expected coverage of a visual inspection. Owing to difficulties of access and other practical problems, it is sometimes not possible to inspect 100% of all areas in a building within a reasonable period of time.

5.2 The danger of prescribing any percentage lower than 100% is the possibility of doing the minimum, with the possible consequence of missing something important. It is therefore generally expected that the structural engineer carry out the visual inspection of all units or areas of a building. This is especially so for buildings where the imposed loading is high, usage varied or likely to be subjected to abuse or overloading, for example factories, industrial buildings, warehouses, shop houses, public assembly areas, etc.

5.3 For other buildings where the imposed loading is light, usage is fairly uniform and unlikely to be subjected to overloading (such as residential apartments, hotel rooms, general office areas), or if a reduced percentage of coverage is inevitable, the structural engineer must have the inspection sampling well distributed throughout the building and no significant defect or deterioration is found during his inspection of the sample. If the structural engineer foresees the possibility of abuse or overloading and detects signs of significant structural defects and possible deterioration, he should consider 100% inspection of the structure.

5.4 All parts of a building with special and critical structural elements or with no redundancy (e.g. cantilever members, transfer column, transfer girder, space truss, connections and support conditions, etc.) must be inspected fully.

6 Repair Works arising from Visual Inspection

6.1 Major repairs and strengthening work, where necessary, shall be treated as building works. As such, procedures relevant to application for approval of plans, permit to carry out building works and supervision of building works shall apply.

6.2 Minor repairs can be treated as routine maintenance and will not require plan submissions or permit applications.

FORMAT OF VISUAL INSPECTION REPORT

7 Main Contents of Report

7.1 A report produced by the structural engineer is expected to be professional, clear and conclusive. A stereotype report written in a manner, which can be used for any building with minor changes to its title block, is defeating the purpose of the Act. On the other hand, a thick book consisting of mainly photographs with no engineering input may also not serve the purpose. The report should therefore reflect the fact that the structural engineer had carried out the inspection in a professional manner with reasonable diligence expected of him as a professional engineer. A well-prepared and professional report is demonstrated by the engineering views, assessment, judgement, conclusion and follow-up recommendations put forth based on the observations. Such a report is also useful for the owner as a maintenance record for any follow-up.

7.2 The following is a guide on the manner in which the Visual Inspection Report could be prepared (a checklist has been included in Annex A to assist structural engineers in their inspections):

a) General Information of the Building

- Name and address of the building
- Number of storeys in each block of building
- Description of main usage of the building
- Maintenance history of the building, if known

b) Structural System of the Building

- Description of the structural forms, systems and materials used in different parts of the building e.g. reinforced concrete, prestressed concrete, steel, etc
- Description of the soil condition and foundation system, if known
- Identification of structures without redundancies for special examination e.g. transfer column, cantilever slabs, cantilever beams, etc

c) Diary and Scope of the Visual Inspection

- Dates of inspection for different parts of the buildings
- Description of any areas not covered by the visual inspection, the reasons and an assessment of whether such areas are critical to overall structural integrity of the building.

d) Survey of Loading on the Building Structure

- Records of and comments on the observations on the loading conditions, indicating the usage at different parts of the building and identifying any misuse, abuse or change of use.
  - State whether existing usage and loading condition is compatible with the intended purpose of the structure.
  - State whether any misuse, abuse or change of use has given rise to excessive loading which can adversely affect the building structure.
- Recommendations on any remedial actions to be taken by the owners e.g. restricting the usage, relocating heavy machineries, further investigation on the adequacy of the structure.

e) Survey of Addition or Alteration Works to Building Structure

- Records of and comments on the findings of any addition and alteration works to the building structure. Such information can be obtained by visual inspection, engineering judgement, interviewing the management corporation, owners and users, and checking the drawings if available to the engineer.
  - State whether any addition and alteration works have given rise to excessive loading or other adverse effects on the building structure.
- Recommendations on any remedial actions to be taken by the owners e.g. the need for the removal of the addition and alteration works.

f) Survey of Signs of Structural Defects, Damages, Distress, Deformation or Deterioration

- Records of observations of any signs of structural defects, damages, distress, deformation or deterioration e.g. cracks, excessive deflection, connection failure, instability, floor settlement, foundation settlement, tilt, spalling concrete, corrosion of steel, termite infestation, dry & wet rot timber, etc. This could entail judicious removal of plaster or architectural finishes to establish the underlying structural condition. The seriousness of any structural defects should be assessed.
- Comments on the extent, possible causes and assessment of the seriousness of these identified problems.
  - Assess whether the identified problems are:
    - Defects of no structural significance
    - Defects requiring remedial action and/or monitoring

        - Suspected defects of structural significance requiring full structural investigation and immediate action
    - Recommendations on remedial actions and/or monitoring necessary to ensure the structural stability and integrity of the building.
    - If there are signs of significant structural problems, the engineer shall make recommendations for a full structural investigation to be carried out without further delay.

g) Other Surveys or Checks Carried Out

- Conditions of high retaining walls.
- Presence of aggressive environments which may accelerate deterioration of structural elements.
- Presence of heavy suspended fixtures in crowded locations, such as heavy false ceilings over high human-traffic areas like food courts, lobbies etc.
- Records of and comments on any known maintenance problems and previous rectification carried out on the building structure. Useful plans, sketches, photographs and tabulations could also be included to illustrate the findings of the inspection;
- Records of and comments on any construction work on adjacent sites which may affect the building under inspection

h) Conclusions

- Conclusions on the structural condition shall include conclusions on loading conditions; addition and alteration works; structural defects, damage, distress, deformation, deterioration; and overall structural integrity and stability.

i) Sketches, Plans and Photographs

- All sketches, plans and photographs should have proper titles, explanations and cross-references to the main body of the report.
- Although photographs are often used by structural engineers as a record of their inspections, the entire collection of photographs should not be submitted indiscriminately, e.g. photographs of non-structural elements with no defects.

j) Structural Engineer's Endorsement and Standard Certification

- The report shall be signed and endorsed by the Structural Engineer appointed to carry out the inspection.
- Depending on the results of the visual inspection, the Structural Engineer shall submit the standard certification form as appropriate.

STAGE 2 : FULL STRUCTURAL INVESTIGATION

8 General

8.1 On the recommendation of the structural engineer who carries out the visual inspection, BCA may grant approval for a full structural investigation to be carried out.

8.2 If the structural deficiencies are of a localised nature, the structural engineer may recommend a full structural investigation for that area in the first instance. The scope and extent of the investigation should be clearly defined and subject to the approval of BCA. The outcome of this investigation may lead to a full structural investigation for the whole building.

8.3 The owner may engage a different structural engineer to carry out the stage 2 inspection and should inform BCA of the appointment.

9 Scope of Full Structural Investigation

9.1 The scope of the full structural investigation includes the following:

(a) obtaining information relating to the design, construction, maintenance and history of the building;
(b) assessing the structural adequacy of the building by checking the structural plans and calculations and reconstructing the structural plans if they are not available;
(c) carrying out tests on the materials used and structural elements of the building;
(d) carrying out load test on parts of the building if necessary;
(e) recommending appropriate safety precautions and remedial measures to restore the structural stability and integrity of the building structure.

ANNEX A - CHECKLIST FOR PERIODIC STRUCTURAL INSPECTION OF EXISTING BUILDINGS

1. Structural layout plans to assess the structural system and identify critical structural elements

2. Type of structural system of the building:
   a) Conventional reinforced concrete
   b) Precast concrete
   c) Prestressed concrete
   d) Structural steel
   e) Masonry
   f) Timber
   g) Others: _____

3. Type of foundation system:
   a) Piles
   b) Footing
   c) Raft
   d) Others: _____

4. Presence of critical structures and structures without redundancies:
   a) Transfer column
   b) Small and slender column
   c) Cantilever structures such as beams and slabs
   d) Others: _____

5. Survey of Loading:
   a) Existing usage compatible with the design loading
   b) There is overloading at unit(s):
      _____
   c) Recommendations of remedial actions to be taken:
      _____

7. Survey of Addition and Alteration Works (A&A):
   a) No A&A was detected
   b) There was A&A at: _____
   c) The A&A has/ has no adverse effect on the building structure
   d) Recommendation of remedial actions to be taken:

      _____

8. Survey of signs of structural defects and deterioration:
   a) Building movement: _____
   b) Structural deformation: _____
   c) Major structural defects e.g. structural cracks:

      _____

   d) Minor structural defects e.g. spalling concrete:

      _____

   e) Non-structural defects:

      _____

   f) Signs of defects/ deformation in retaining wall e.g. cracks, tilt:

      _____

   g) Signs of undesirable condition surrounding retaining wall e.g. tension cracks in soil, weephole chokage, presence of big trees nearby, inadequate surface drainage: _____
   h) Other defects: _____
   i) Recommendation of remedial actions to be taken:

      _____

9. Other Surveys:
   a) Presence of aggressive environments: _____
   b) Presence of heavy suspended fixtures at areas of public assembly/ high human traffic. The areas are at:

      _____

   c) Record of previous strengthening works done
   d) Presence of construction work nearby which may affect the building
   e) Signs of possibility of debonding of tiles at:

      _____

10. Other information:

    _____