Building and Construction Authority

An MND Statutory Board
In Collaboration With

ASSOCIATION OF CONSULTING ENGINEERS SINGAPORE

Our ref : APPBCA-2022-20

1 September 2022

To: Building Owners, Developers, Engineers, Builders and Facility Managers

For enquiries, please contact:
Building Resilience Group (#10-01)
Tel: 1800 3425 222 (1800-DIAL-BCA)
or use our Online Feedback Form at:
https://www.bca.gov.sg/feedbackform/

# JOINT BCA / IES / ACES CIRCULAR 2022

## ENHANCEMENTS TO GUIDELINES ON PERIODIC STRUCTURAL INSPECTION

The Periodic Structural Inspection (PSI) regime introduced in 1989 plays an important role to ensure Singapore's built environment remains safe for its users. Professional Engineers (PEs) engaged to conduct PSI have an important responsibility to ensure that inspection is carried out with due diligence and in a professional manner.

2 As part of BCA's regular review of the PSI, we have jointly reviewed with IES and ACES to update the "Guidelines for Structural Engineers" (Guidelines), taking into consideration past building incidents, emerging issues and feedback from industry. The amendments made aim to further improve the standard of inspection across the PEs by:

i) providing clarity on minimum inspection coverage for concealed structural elements in residential and non-residential buildings;
ii) incorporating lessons learnt from past building incidents;
iii) addressing higher risk of ageing buildings; and
iv) incorporating new and emerging construction technologies (PPVC, MET)

Please see **Annex A** on the updates made to the Guidelines.

3 For all buildings with PSI Notices issued from 1 January 2023 onwards, PEs appointed for PSI should refer to and follow the requirements stated in the updated 'Guidelines for Structural Engineers", which can be downloaded from BCA's website at https://www1.bca.gov.sg/regulatory-info/building-control/periodic-structural-inspection .

### Clarification

4 Please bring the contents of this Circular to the attention of your members. Should you need any clarification, please submit your enquiry through BCA's Online Feedback Form at https://www.bca.gov.sg/feedbackform/ or call us at 1800 342 5222.

5 Thank you.

Building and Construction Authority

An MND Statutory Board

Yours faithfully

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# ANNEX A: DETAIL OF ENHANCEMENTS TO PSI GUIDELINES FOR STRUCTURAL ENGINEERS

| No | Item | Enhancements to PSI Guidelines for Structural Engineers (amendments underlined) |
|---|---|---|
| 1 | **Para 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 the periodic structural inspection of existing buildings are stipulated in Part 5 of the Building Control Act 1989 ("BC Act") and Part 2 of the Building Control (Periodic Inspection of Buildings and Building Facades) Regulations 2021 ("BC Regs"). For guidance relating to periodic inspection of building facades under Part 5 of the BC Act, information can be found in the separate document "Guidelines on Periodic Façade Inspection". |
| 2 | **Para 2 Qualifications and Expectation of Structural Engineers** | 2.3 The structural engineer is required to comply with the deadlines stated in the periodic structural inspection notice and written direction(s). If the structural engineer is unable to comply with the deadline, he/she shall apply for a written extension of time to BCA at least 5 days before the deadline.<br><br>2.4 Under Section 28(4) of the BC Act, where a building comprising 2 or more flats is not subdivided and there are subsisting leases for those flats registered under the Registration of Deeds Act 1988 or the Land Titles Act 1993, all the owners of those flats must jointly appoint the same structural engineer to carry out the periodic structural inspection. The structural engineer shall only commence the periodic structural inspection after he/she has been jointly appointed by all owners of the building. |
| 3 | **Para 3 Scope of Visual Inspection** | 3.1 Prior to commencing the visual inspection, the structural engineer is required to obtain a set of the building's latest structural layout plans from the Building and Construction Authority. The structural layout plans will help the structural engineer to:<br><br>(a) understand the structural system and layout of the building;<br>(b) identify special and critical structures[1] for inspection;<br>(c) identify structures without redundancies[2];<br>(d) identify small-size, narrow or slender RC columns in void deck of residential buildings built before 1989 and using grade 20 concrete;<br>(e) identify the allowable imposed loads, in order to assess the usage and possibility of overloading; and<br>(f) identify structural works that are or were carried out without any prior approval of the plans of those works where prior approval is required by Part 2 of the BC Act;<br><br>3.2 In general, the structural engineer is expected to carry out, with reasonable diligence, a visual inspection, which must include a visual survey carried out personally, of:<br>a) the condition of the building<br>- to identify the types of structural defects;<br>- to identify the signs of structural defect, deformation or deterioration;<br><br>b) the loading on the structure of the building<br>- to identify any deviation from intended use, misuse and abuse which can result in overloading<br><br>c) any unauthorised addition or alteration works |

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| | | to identify evidence of any structural works that are or were carried out without any prior approval of the plans of those works where prior approval is required by Part 2 of the BC Act<br>...<br>3.5 In the course of his inspection, if the structural engineer observes any building elements (e.g. architectural finishes, M&E finishes) at risk of partial/total collapse, the structural engineer should inform the owner of the building as soon as possible, and highlight in his report. |
| **4** | **Para 4 Coverage of Visual Inspection** | 4.1 The visual inspection shall cover all structural elements within the building(s) at the stated address.<br><br>4.2 In a situation where the structural engineer assesses that it is not possible to inspect 100% of all areas in a building, professional judgement must be exercised to determine any reduced coverage of inspection that may be considered to obtain a sampling representative of the building's condition. Reference to structural layout plans to determine the presence of special and critical structures[1] and structures without redundancies[2] would be crucial under such circumstances.<br><br>4.3 When reduced coverage of inspection is inevitable, structural engineer shall fulfil the minimum requirements as set out below:<br><br>*4.3.1 Residential Developments*<br>(a) All special and critical structures[1] and structures without redundancies[2] must be visually inspected. If such structures are concealed by architectural finishes, access shall be made to inspect the concealed structure.<br><br>(b) All unconcealed structural elements should be visually inspected.<br><br>(c) All structural elements in the common area (e.g. corridor, stairway, lift lobby, clubhouse) must be inspected.<br><br>(d) At least 20% (≤30 years old building) or 30% (>30 years old building)[3] of the residential units must be accessed for inspection to be carried out. The units selected should be well-distributed and representative of the building's structural condition. The selection of units shall fulfil the following:<br>• All rooftop units must be accessed and inspected<br>• At least 1 unit per storey on all other storeys must be accessed and inspected<br>• The units selected for inspection should be well distributed (i.e. units inspected are situated at different wings in the tower/block)<br>If there is more than 1 residential tower/block (including cases where multiple buildings are connected by link-bridges), the criteria above will apply to each and every block/tower.<br><br>(e) For cladded columns[4], the structural engineer shall expose at least 30% of the cladded columns for inspection, and exercise professional judgement if more columns (>30%) need to be exposed to obtain a representative assessment. The |

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| | | owner shall arrange for the removal of the claddings or concealments in order to provide access for such inspections<br>By performing (a) – (e), the structural engineer can expect to visually inspect at least 70% - 80% of the building's structural elements.<br><br>*4.3.2 Non-residential Developments (e.g. Commercial/Industrial)*<br>(a) All special and critical structures[1] and structures without redundancies[2] must be visually inspected. If such structures are concealed by architectural finishes, access shall be made to inspect the concealed structure<br><br>(b) All units and unconcealed structural elements should be visually inspected<br><br>(c) For indoor areas not exposed to weather and covered by suspended ceilings, at least 1 suspended ceiling should be accessed every 500m$^2$<br><br>(d) For outdoor areas exposed to weather (e.g. outdoor shelter, pickup/dropoff point) and covered by suspended ceiling, at least 1 suspended ceiling should be accessed every 250m$^2$<br><br>(e) For cladded columns[4], the structural engineer shall expose at least 30% of the cladded columns for inspection, and exercise professional judgement if more columns (>30%) need to be exposed to obtain a representative assessment. The owner shall arrange for the removal of the claddings or concealments in order to provide access for such inspections<br><br>*4.3.3 Mixed Use Developments (e.g. Shophouses, Integrated Developments)*<br>(a) For residential towers/blocks in the building, please refer to Section 4.3.1 on minimum inspection coverage<br><br>(b) For the remaining areas of the building, please refer to Section 4.3.2 on minimum inspection coverage.<br><br>4.4 Notwithstanding the minimum requirements for inspection coverage set out in Section 4.3.1 to Section 4.3.3, the structural engineer shall exercise his professional judgement and make an assessment if higher inspection coverage is required. A list of factors that will warrant higher inspection coverage should include, but are not limited to:<br>i) Age<br>ii) Areas of high humidity/Wet area (e.g. toilet)<br>iii) Cause(s) and extent of defect(s) observed<br>iv) Exposure condition of the building (e.g. heat, proximity to aggressive environment<br>v) Maintenance history of past defects and past strengthening works<br>vi) Complex structural layout (e.g. long span, transfer structure, different structural systems)<br>vii) Visibility of concealed structural elements based on line of sight from inspection point of suspended ceiling |

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| | | Please refer to Annex D for suggested increased inspection coverage by structural engineer due to the factors i), iii) and v) above.<br><br>4.5 If the structural engineer assesses that the concealed structural element(s) needs to be inspected, the owner, under Section 28 (5) and (5A) of the BC Act, must allow and facilitate the removal of architectural finish for the structural engineer's inspection.<br><br>4.6 The structural engineer shall provide justifications in his visual inspection report that his inspection coverage is representative of the building's condition. The report should clearly illustrate the areas that have been inspected on a building layout plan. A summary of inspected area should be included (e.g. listing of all units that were inspected). |
| **5** | **Para 5<br>Main Contents of the Report** | A report produced by the structural engineer is expected to be professional, clear and conclusive. A report written in a manner, which can be used for any building with minor changes to its title block, defeats the purpose of the Act. On the other hand, a thick book consisting of mainly photographs with no engineering input also does not serve the purpose. The report should therefore reflect the fact that the structural engineer has carried out the inspection in a professional manner with reasonable diligence expected of him as a professional engineer. A well-prepared and professional report should consist of engineering views, assessment, judgement, conclusion, and follow-up recommendations put forth based on the engineer's observations. Such a report is also useful for the owner as a maintenance record for any follow-up.<br><br>5.1 The following serves to guide the structural engineer when preparing the Visual Inspection Report. In addition, a checklist in Annex A is to be included as part of the inspection report.<br><br>- **General Information of the Building**<br>- Name and address of the building<br>- Number of storeys in each block of building<br>- Description of main usage of the building<br>- Maintenance history of the building, if known<br><br>- **Structural System of the Building**<br>- Description of the structural systems and materials[5] used in different parts of the building<br>- Description of the soil condition and foundation system, if known<br>- Identification of special and critical structures[1]<br>- Identification of structures without redundancies[2]<br>- Identification of concealed key structural elements and connection systems of Prefabricated Prefinished Volumetric Construction (PPVC) constructed buildings<br>- Identification of Timber Structures<br><br>… |

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| | | - **Survey of Unauthorised Works[6] to Building Structure**<br>- Records of and comments on the findings of any unauthorised works to the building structure. Such information can be obtained by visual inspection, engineering judgement, interviewing the management corporation, owners, tenants and users, and checking the drawings<br>- State whether the unauthorised works have caused excessive loading or other adverse effects on the building structure.<br>- To advise the owner to demolish/regularise the structure<br><br>...<br><br>- **Recommended remedial actions for all defects detected**<br>- For all defects detected, the engineer will need to recommend the appropriate remedial actions and procedure to be taken by the owner, such as:<br>- Restricting the usage, or relocation of heavy machineries<br>- Need for the removal of the unauthorised works<br>- Need for inspection and treatment by an anti-termite specialist, and obtain the certificate of termite treatment accordingly<br>- Need for timber specialist to advise on required rectification works for MET structure<br>- Recommendation of measures to address areas at risk of water ingress in MET structure<br>- Need for regular maintenance checks on condition of heavy suspended fixtures (e.g. thick cement plaster, large cement-based or gypsum board over) in crowded locations, such as food courts, atrium, waiting/seating areas<br>- In cases where spalling concrete is observed, the engineer shall carry out simple test (e.g. tapping) in other areas to identify risk of spalling<br>- Recommendation for further monitoring/structural investigation necessary to ensure the structural stability and integrity of the building<br>- 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<br><br>- **Inspection Coverage**<br>- Summarised list of inspected units<br>- Location of cladded columns exposed for inspection in a structural/building layout plan<br>- Location of suspended ceiling accessed in a structural/building layout plan<br>- Justification of inspection coverage<br><br>- **Conclusions**<br>- Conclusions on the structural condition shall include observations on loading conditions; unauthorised works[6]; structural defect(s), deformation(s) or deterioration; and overall structural integrity and stability.<br><br>- **Sketches, Plans and Photographs**<br>- All sketches, plans and photographs should be produced in a clear and legible manner with proper titles, explanations and cross-references to the main body of the report. |

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| | | - 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)<br><br>- **Structural Engineer's Endorsement and Standard Certification**<br>- The report shall be signed and endorsed on the first and last page by the Structural Engineer appointed to carry out the inspection as follows.<br><br>**Standard Certification by the Structural Engineer for Periodic Inspection of Buildings**<br><br>In accordance with Section 28(6) of the Building Control Act 1989 (the "Act") and Regulations 6 and 7 of The Building Control (Periodic Inspection of Buildings and Building Façade) Regulations 2021 (the "Regulations"), I, _____, the Structural Engineer appointed by the building owner under section 28(3) of the Act have personally conducted a structural inspection of the building located at [pls state address] ("**Building**"), including a visual survey carried out personally, and hereby submit the report of my inspection of the Building. I certify and declare that the inspection of the Building was carried out and the report was prepared by me in accordance with the Act and the Regulations.<br><br>_____ _____<br>Structural Engineer<br>For Periodic Inspection of Buildings Date<br>(Signature and Stamp)<br><br>- Depending on the results of the visual inspection, the Structural Engineer shall submit the Visual Inspection Certification (Form SF_ESID_SIS/SF-D3) as appropriate.<br><br>5.2 A supplementary checklist in Annex B is to be included in the visual inspection report for residential buildings with small-sized, narrow or slender RC columns in void deck of residential buildings built before 1989 and using grade 20 concrete. For such structural elements, lack of maintenance, natural deterioration, accuracy of rebar placement, support settlement, or accidental impact force (eg. from vehicles in void deck carparks) can significantly affect the load capacity. Hence, structural engineers are to be thorough in identifying early signs of deterioration/ distress and seriously consider recommending a full structural investigation in order to ascertain the structural integrity of the columns as well as the need for strengthening or protection. |
| **6** | **Definitions** | [1] Examples of special and critical structures are transfer girders/ beams/ trusses, small / slender columns, long span structures, cable structures, inclined columns, etc.<br>[2] Example of structures without redundancies are cantilever structures, cantilever structures without backspan, cantilever balconies exposed to elements, tension columns, |

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| | | hanging/suspended structures, nibs and corbels, etc. Reference should also be made to Annex C.<br>[3] For residential buildings ≥40 years old, refer to Annex D.<br>[4] Columns concealed behind architectural finishes with air gaps between the column face and the finishes. It excludes those columns concealed with materials adhered fully to the column face, i.e. tiles, plaster, wallpaper<br>[5] Structural materials such as reinforced concrete, pre-stressed concrete, steel, etc.<br>[6] Evidence of any structural works that are or were carried out without any prior approval of the plans of those works where prior approval is required by Part 2 of the Building Control Act |
| 7 | **Annex A – CHECKLIST FOR PERIODIC STRUCTURAL INSPECTION OF EXISTING BUILDINGS** | Please tick Y or N/A, which are defined below, accordingly for all checklist items:<br><br>**Y** – Yes, I declare that I have checked and addressed the item in my report<br>**N/A –** Not applicable, I declare that I have checked and found the item to be not applicable (i.e. does not exist)<br><br>**1. Structural System of the Building:**<br>a) Reference to structural layout plans and details<br>b) Description of foundation system<br>c) Description of structural system (including storey height)<br>d) Location of critical floor systems (e.g. flat slab, flat plate or pre-stressed slab etc.), if any<br><br>**2. Special and Critical Structures[B]:**<br>a) Signs of distress, cracks, deformation or corrosion<br>*[B] Examples of special and critical structures are transfer girders/ beams/ trusses, small / slender columns, long span structures, cable structures, inclined columns, etc.*<br><br>**3. Structures without redundancies[C]:**<br>a) Signs of distress, cracks, deformation or corrosion<br>*[C] Examples of structures without redundancies are cantilever structures, cantilever structures without backspan, cantilever balconies exposed to elements, tension columns, hanging/suspended structures, nibs and corbels, etc. Reference should also be made to Annex C.*<br><br>**4. Concealed key structural elements and connection systems of Prefabricated Prefinished Volumetric Construction (PPVC) constructed buildings:**<br>a) Reference to approved structural plans for location and detail of inspection access points<br>b) Signs of distress, deformation or corrosion on concealed structural elements and connection systems<br><br>**5. Timber structures (including Mass Engineered Timber):**<br>a) Signs of biological damage or decay (e.g. termite attack or fungus growth, etc.)<br>b) Signs of deterioration (e.g. creep deformation, delamination, cracks, etc.)<br>c) Areas prone to water leakage, accumulation of water that can result in ingress of water (e.g. end cap protection remain intact and water tight, waterproofing is still effective) |

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| | | d) Increase in moisture content beyond code and specialist recommendations checked using devices such as moisture meters and scanners.<br>e) Need for inspection and testing by a specialist (e.g. anti-termite, timber specialist, etc.)<br><br>**6. Survey of Loading:**<br>a) Compatibility of existing usage with the design loading<br>b) Deviation from intended use or supporting higher imposed load as recommended in the design codes (e.g. CP 3, BS 6399 or SS EN 1991 and the relevant national annexes)<br>c) Signs of distress or deformation due to overloading (to show affected location(s) on plan)<br><br>**7. Unauthorised Works[D]:**<br>a) Presence of unauthorised works (to show locations on plan)<br>b) Impact of unauthorised works on the building structure<br>c) Record of previous strengthening works without Approved Plans.<br>d) Additional unauthorised floor within a high volume/headroom space<br>*[D] Examples of slope protection structures are soil nails, ground anchors, shotcrete slope, etc.*<br><br>**8. Signs of structural defects and deterioration:**<br>a) Building tilt/ settlement<br>b) Structural deformation<br>c) Major structural defects (e.g. structural cracks, decayed timber member, etc.)<br>d) Minor structural defects (e.g. minor corrosion and minor spalling, etc.)<br>e) Non-structural defects<br><br>**9. Exposure to aggressive environment:**<br>a) Column immersed in water (e.g. ground floor water tank, seawater, lakes, etc.)<br>b) Aggressive chemicals or other similar substances which may accelerate the deterioration of structural elements, particularly in industrial buildings<br><br>**10. Slope, retaining walls and slope protection structures[E]:**<br>a) Signs of slope erosion<br>b) Defects of retaining wall and other slope protection structures (e.g. cracks, tilt, displacement, etc.)<br>c) Signs of undesirable condition surrounding retaining wall (e.g. tension cracks in soil, choked weephole(s), presence of big trees nearby, inadequate surface drainage etc.)<br>*[E] Soil nails, ground anchors, shotcrete slope, etc.*<br><br>**11. Safety Barriers (i.e. parapets & railings):**<br>a) Any signs of structural defect, deformation or deterioration |

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| | | b) Any continuous handrail for full glass barriers<br><br>**12. Other Surveys or Checks carried out**<br>a) Presence of heavy suspended fixtures (e.g. thick cement plaster, large cement-based or gypsum board over) in crowded locations, such as food courts, atrium, waiting/seating areas<br>b) Records of and comments on any known maintenance problems and previous rectification carried out on the building structure.<br>**13. Inspection Coverage**<br>a) Summarised list of units inspected<br>**a.** Percentage of units inspected: %<br>b) At least 30% of cladded columns[F] are exposed for inspection<br>a. Percentage of cladded columns[F] exposed: %<br>c) Suspended ceiling accessed are indicated on a structural/building layout plan<br>d) Justification of inspection coverage<br><br>**14. Recommended remedial actions for all defects detected**<br><br>**15. Standard Certification on first and last page of report** |
| **8** | **ANNEX B – SUPPLEMENTARY CHECKLIST[G] FOR CRITICAL COLUMNS IN RESIDENTIAL BUILDINGS(S) BUILT BEFORE 1 JAN 1989** | Please tick Y or N/A, which are defined below, accordingly for all checklist items:<br><br>**Y** – Yes, I declare that I have checked and addressed the item in my report<br>**N/A –** Not applicable, I declare that I have checked and found the item to be not applicable (i.e. does not exist) |
| **9** | **ANNEX C – CRITERIA FOR COMPLEX BUILDING** | A building is deemed to be complex if it consists of one or more of the following:<br><br>1) Multiple level transfer structures (2 or more transfer floors each carrying 3 or more floors) or cantilevered transfer structures (carrying 5 or more floors);<br><br>2) Non-vertical/inclined structural elements (with offset of floor plate more than 3m from the edge of the floor above or below);<br><br>3) Structures with unconventional geometry (e.g. dome or arch-shaped); or<br><br>4) Large span structures (with span more than 40m) or large cantilever span structures (where cantilever span is more than 8m). |
| **10** | **ANNEX D – GUIDELINES FOR ADDITIONAL INSPECTION COVERAGE DUE TO AGE, DEFECTS OBSERVED AND MAINTENANCE HISTORY** | Notwithstanding the minimum requirements for inspection coverage set out in Section 4.3.1 to Section 4.3.3 of the guidelines, Annex D provides greater details on the guiding principles for the structural engineer when assessing the additional inspection coverage required when certain risk factors are observed.<br><br>**I) AGE**<br>Historically, we noticed that older buildings have a greater percentage of buildings with structural defects observed. As such, a higher inspection coverage is recommended to detect and identify localised degradation/deterioration of building material. Unless buildings have |

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undergone major structural improvement/strengthening works, buildings >40 years old are recommended to adhere to the following inspection coverage:<br><br>
Residential Developments<br><br>
<table>
<tr><th>Age</th><th>Percentage of units to be inspected (%)</th></tr>
<tr><td>> 40 years old</td><td>40%</td></tr>
<tr><td>> 60 years old</td><td>60%</td></tr>
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<br>
Non-residential Developments<br>
The increased coverage would require PE to access the suspended ceiling access panels at smaller intervals than 500m$^2$ (indoor areas) and 250m$^2$ (outdoor areas) specified in Section 4.3.2. Depending on the line of sight, the structural engineer will have to make an assessment of the inspection intervals.<br><br>
II) CAUSE(S) AND EXTENT OF DEFECT(S) OBSERVED<br><br>
Depending on the cause and extent of defect(s) observed, the location and amount of additional inspection coverage required may vary. As a general guidance, the recommended additional inspection for commonly observed defects are:<br><br>
A) Signs of distressed structural elements<br>
- Inspection should be extended to structural elements that may undertake the redistributed loading<br><br>
B) Corrosion-related defects due to exposure conditions (e.g. corroded rebar, connection or structural steel elements)<br>
- Inspection should be extended to areas in the building with high humidity, or exposed to aggressive environment. Other areas in the building with similar exposure condition should also be inspected<br><br>
C) Degradation of building material due to age (e.g. spalled concrete)<br>
- In such cases, inspection coverage should generally be increased throughout the building to establish the extent of structural defect and to obtain a better representation of building condition.<br>
- The increased coverage should consist of inspecting more residential units, and/or accessing the suspended ceiling access panels at smaller intervals than 500m$^2$ (indoor areas) and 250m$^2$ (outdoor areas) to establish the extent of structural defects<br><br>
For defects observed and not listed above, due diligence should be exercised by the structural engineer to:<br>
i) assess the additional inspection coverage required, and<br>
ii) justify his/her assessment<br><br>
III) MAINTENANCE HISTORY OF PAST DEFECTS AND PAST STRENGTHENING WORKS<br><br>
The maintenance history of a building is telling of the likely defects that may be observed in a building. The structural engineer should customise the inspection coverage, inspection methodology and repair methodology based on findings from the building's maintenance history. For example:<br><br>
i) Water leakage at RC roof will have a higher likelihood of spalling concrete occurring than a ceiling slab observed on other floors. Hence, the Structural Engineer is
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| | | expected to exercise due diligence and carry out simple, appropriate tests (e.g. tapping) at Stage 1: Visual Inspection to detect signs of hollowness.<br><br>ii) Improper or incorrect repair of spalling concrete, cracks and holes such as incorrect repair procedure or use of unsuitable materials. This will result in the spalling concrete continuing to deteriorate undetected underneath the fresh coats of repair. Hence, SE is expected to review past repair methodology |