Building and Construction Authority

PERIODIC STRUCTURAL INSPECTION OF EXISTING BUILDINGS

GUIDELINES

FOR

STRUCTURAL ENGINEERS

SEP 2024

Preamble

The ‘Guidelines for Structural Engineers’ has been prepared by the Building and Construction Authority (“**BCA**”), with the inputs of the Association of Consulting Engineers Singapore (“**ACES**”) and the Institution of Engineers Singapore (“**IES**”) to provide information and a better understanding on periodic structural inspections of buildings.

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DEFINITIONS

Special and critical structures[1]	[1] Examples of special and critical structures are transfer girders/ beams/ trusses, small / slender columns, long span structures, cable structures, inclined columns, etc.
Structures without redundancies[2]	[2] Example 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.
Additional inspection coverage[3]	[3] Additional inspection coverage that are required due to age, defects observed and maintenance history
Concealed columns[4]	[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
Structural materials[5]	[5] Structural materials such as reinforced concrete, pre-stressed concrete, steel, etc.
Unauthorised works[6]	[6] Any structural works that are or were carried out without any prior approval by the Commissioner of Building Control of the plans of those works where prior approval is required under Part 2 of the Building Control Act 1989

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 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".

1.2 The periodic structural inspection applies to all existing buildings other than:

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 (SE)

2.1 The BC 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 and who has in force a practising certificate issued under the Professional Engineers Act 1991 authorising him or her to engage in civil or structural engineering work. It is so due to the need for and importance of a professional assessment and judgement in structural engineering during the visual inspection.

2.2 The structural engineer appointed by the building owner is therefore expected to carry out a comprehensive visual inspection that relies largely on his/her professional engineering assessment and judgement. He/She shall exercise reasonable diligence and take active interest in the planning and carrying out of the inspection of the building. It is not an acceptable practice for the structural engineer to not visit the building or to delegate the entire inspection work to his/her assistant or any other person who is not a registered professional engineer in the civil and structural discipline.

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.

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 a structural inspection. The structural engineer shall only commence the structural inspection after he/she has been jointly appointed by all owners of the building.

STAGE 1: VISUAL INSPECTION

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 plan will help the structural engineer to:

(a) understand the structural system and layout of the building;
(b) identify special and critical structures[1] for inspection;
(c) identify structures without redundancies[2];
(d) identify small-size, narrow or slender RC columns in void deck of residential buildings built before 1989 and using grade 20 concrete;
(e) identify the allowable imposed loads, in order to assess the usage and possibility of overloading; and
(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.

3.2 In general, the structural engineer is expected to carry out, with reasonable diligence, a visual inspection, which must also include a visual survey carried out personally, of:

a) the condition of the building
- to identify the types of structural defects;
- to identify the signs of structural defect, deformation, or deterioration;

b) the loading on the structure of the building
- to identify any deviation from intended use, misuse and/or abuse which can result in overloading; and

c) any unauthorised works
- 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.

3.3 If there are no signs of defect, deformation or deterioration, the visual inspection should suffice.

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

3.5 In the course of his/her inspection, if the structural engineer observed 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/her report.

4 Coverage of Visual Inspection

4.1 The visual inspection shall cover all structural elements within the building(s) at the stated address.

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.

4.3 When reduced coverage of inspection is inevitable, structural engineer shall fulfil the minimum requirements as set out below:

4.3.1 *Residential Developments*

(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.

(b) All unconcealed structural elements should be visually inspected.

(c) All structural elements in the common area (e.g. corridor, stairway, lift lobby, clubhouse) must be inspected.

(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:

- All rooftop units must be accessed and inspected
- At least 1 unit per storey on all other storeys must be accessed and inspected
- The units selected for inspection should be well distributed (i.e. units inspected are situated at different wings in the tower/block)

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.

(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.

(f) For concealed structural elements (i.e. beam and slab) within the selected residential units, the structural engineer shall inspect via appropriate access points (e.g. lighting points, access panels, and the like).

By performing (a) – (f), the structural engineer can expect to visually inspect at least 70% - 80% of the building's structural elements.

4.3.2 *Non-residential Developments (e.g. Commercial/Industrial)*

(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 structures

(b) All units and unconcealed structural elements should be visually inspected

(c) For indoor areas not exposed to weather and covered by suspended ceilings, at least 1 suspended ceiling should be accessed every 500m^2

(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

(e) For cladded columns[4], the structural engineer shall expose at least 30% of the cladded columns for inspection, and exercise professional judgement to decide if more columns need to be exposed to obtain a representative assessment. The owner shall provide access and arrange for the removal of the claddings or concealments for such inspections.

4.3.3 *Mixed Use Developments (e.g. Shophouses, Integrated Developments)*

(a) For residential towers/blocks in the building, please refer to Section 4.3.1 on minimum inspection coverage

(b) For the remaining areas of the building, please refer to Section 4.3.2 on minimum inspection coverage.

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/her 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:

i) Age
ii) Areas of high humidity/Wet area (e.g. toilet)
iii) Cause(s) and extent of defect(s) observed
iv) Exposure condition of the building (e.g. heat, proximity to aggressive environment
v) Maintenance history of past defects and past strengthening works
vi) Complex structural layout (e.g. long span, transfer structure, different structural systems)
vii) Visibility of concealed structural elements based on line of sight from inspection point of suspended ceiling

Please refer to Annex D for suggested increased inspection coverage by structural engineer due to the factors i), iii) and v) above.

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 finishes for the structural engineer's inspection.

4.6 The structural engineer shall provide justifications in his/her visual inspection report that his/her 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).

4.7 PSI at 5-yearly intervals is required for the following civil engineering structures: jetties, docks, wharves, bridges, underpasses and floating structures. When conducting PSI for the building, the structural engineer should also inspect the surrounding structures within the building premise and include their assessment in their report. (*updated as of Sep 2024*)

FORMAT OF VISUAL INSPECTION REPORT

5 Main Contents of 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.

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.

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 systems and materials[5] used in different parts of the building
- Description of the soil condition and foundation system, if known
- Identification of special and critical structures[1]
- Identification of structures without redundancies[2]
- Identification of concealed key structural elements and connection systems of Prefabricated Prefinished Volumetric Construction (PPVC) constructed buildings
- Identification of Timber Structures

c) Diary and Scope of the Visual Inspection

- Date(s) of inspection(s)
- 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. Special attention to be paid to industrial buildings (e.g. factories and warehouses etc.). In the report, structural engineers shall state if:
  - existing usage and loading condition is compatible with the intended purpose of the structure
  - any misuse, abuse and/or deviation from intended use resulted in excessive loading which can adversely affect the building structure

- Where there is deviation from its intended use resulting in overloading or supporting higher imposed load as recommended in the design code such as CP3, BS 6399 or SS EN 1991 (and the relevant national annexes), the structural engineer shall recommend:
  - the need for further design checks to assess structural adequacy
  - the display of allowable imposed loading signage to ensure that building users are aware of the loading limit.

e) Survey of Unauthorised Works[6] to Building Structure

- 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
- State whether the unauthorised works have caused excessive loading or other adverse effects on the building structure.
- To advise the owner to demolish/regularise the structure

f) Survey of Signs of Structural Defect, Deformation or Deterioration

- Records of any signs of structural defect, 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.
- Comments on the extent, possible causes and assessment of the seriousness of these identified problems.
- Severity of the identified problems shall also be assessed to determine if they 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

g) Survey of exposure to aggressive environment

- Presence of column(s) immersed in water (e.g. ground floor water tank, seawater, lakes, etc.)
- Presence of aggressive chemicals or other similar substances, which may accelerate the deterioration of structural elements, particularly in industrial buildings.

h) Survey of slope, retaining walls and slope protection structures (e.g. soil nails, ground anchors, shotcrete slope)

- Evidence of wall/slope movement, inadequate surface drainage, unintended imposed loading behind wall, corrosion of anchor blockhead, spalling of shotcrete protection, tension cracks etc.

i) Survey of safety barriers (e.g. parapets and railings)

- Signs of corrosion, excessive deflection, spalling, cracks, etc. observed on safety barriers particularly those in buildings where large crowds are expected (e.g. shopping malls, institutional buildings, sport halls, stadiums, theatres, etc)

j) Other Surveys or Checks Carried Out

- 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
- 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.

k) Recommended Remedial Actions For All Defects Detected

- For all defects detected, the engineer will need to recommend the appropriate remedial actions and procedure to be taken by the owner, such as:
    - Restricting the usage, or relocation of heavy machineries
    - Need for the removal of the unauthorised works
    - Need for inspection and treatment by an anti-termite specialist, and to obtain the certificate of termite treatment accordingly
    - Need for timber specialist to advise on required rectification works for MET structure
    - Recommendation of measures to address areas at risk of water ingress in MET structure

- 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
- 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
- Recommendation for further monitoring/structural investigation necessary to ensure the structural stability and integrity of the building
- Major repairs and strengthening work, where necessary, shall be treated as building works. As such, procedures relevant to application for approval of plans or permit to carry out building works and supervision of building works shall apply

l) Inspection Coverage

- Summarised list of inspected units
- Location of cladded columns exposed for inspection in a structural/building layout plan
- Location of suspended ceiling accessed in a structural/building layout plan
- Justification of inspection coverage

m) Conclusions

- Conclusions on the structural condition of the building shall include observations on loading conditions; unauthorised works[6]; structural defect(s), deformation(s) or deterioration; and overall structural integrity and stability.

n) Sketches, Plans and Photographs

- 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.
- 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)

o) Structural Engineer's Endorsement and Standard Certification

- 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.

Standard Certification by the Structural Engineer for Periodic Inspection of Buildings

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.

_____	_____
Structural Engineer For Periodic Inspection of Buildings (Signature and Stamp)	Date

- 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.

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.

STAGE 2: FULL STRUCTURAL INVESTIGATION

6 General

6.1 On the recommendation of the structural engineer who has carried out the visual inspection, BCA may grant approval to carry out a full structural investigation.

6.2 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 are subject to the approval of BCA. The outcome of this first localised investigation may lead to a full structural investigation for the whole building.

6.3 The owner may engage a different structural engineer to carry out the stage 2 inspection and should inform BCA of the appointment by way of a written notice before such inspection is carried out.

7 Scope of Full Structural Investigation

7.1 The scope of the full structural investigation includes but is not limited to the following:

(a) Information relating to the design, construction, maintenance and history of the building;
(b) Assessment of the structural adequacy of the building by checking the structural plans and calculations and reconstructing the structural plans
(c) Carry out tests on the materials used and structural elements of the building;
(d) Carry out load test on parts of the building if necessary;
(e) Recommend appropriate safety precautionary and remedial measures to restore the structural stability and integrity of the building structure.

ANNEX A – CHECKLIST[A] FOR PERIODIC STRUCTURAL INSPECTION OF EXISTING BUILDING(S) AT_____

<*Building Address*>

Please tick Y or N/A, which are defined below, accordingly for all checklist items:

Y – Yes, I declare that I have checked and addressed the item in my report
N/A – Not applicable, I declare that I have checked and found the item to be not applicable (i.e. does not exist)

	Y	NA
1. Structural System of the Building:		
a) Reference to structural layout plans and details		
b) Description of foundation system		
c) Description of structural system (including storey height)		
d) Location of critical floor systems (e.g. flat slab, flat plate or pre-stressed slab etc.), if any		
2. Special and Critical Structures[B]:		
a) Signs of distress, cracks, deformation or corrosion		
3. Structures without Redundancies[C]:		
a) Signs of distress, cracks, deformation or corrosion		
4. Concealed Key Structural Elements And Connection Systems Of Prefabricated Prefinished Volumetric Construction (PPVC) Constructed Buildings:		
a) Reference to approved structural plans for location and detail of inspection access points		
b) Signs of distress, deformation or corrosion on concealed structural elements and connection systems		

[A] This checklist is to be included in the inspection report.

[B] Examples of special and critical structures are transfer girders/ beams/ trusses, small / slender columns, long span structures, cable structures, inclined columns, etc.

[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.

		Y	NA
5.	**Timber structures (including Mass Engineered Timber):**		
a)	Signs of biological damage or decay (e.g. termite attack or fungus growth, etc.)		
b)	Signs of deterioration (e.g. creep deformation, delamination, cracks, etc.)		
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)		
d)	Increase in moisture content beyond code and specialist recommendations checked using devices such as moisture meters and scanners.		
e)	Need for inspection and testing by a specialist (e.g. anti-termite, timber specialist, etc.)		
6.	**Survey of Loading:**		
a)	Compatibility of existing usage with the design loading		
b)	Deviation from intended use or supporting higher imposed load as recommended in the design codes (e.g. CP3, BS 6399 or SS EN 1991 and the relevant national annexes)		
c)	Signs of distress or deformation due to overloading (to show affected location(s) on plan)		
7.	**Unauthorised Works[D]:**		
a)	Presence of unauthorised works (to show locations on plan)		
b)	Impact of unauthorised works on the building structure		
c)	Record of previous strengthening works without Approved Plans.		
d)	Additional unauthorised floor within a high volume/headroom space		
8.	**Signs of structural defects and deterioration:**		
a)	Building tilt/ settlement		
b)	Structural deformation		
c)	Major structural defects (e.g. structural cracks, decayed timber member, etc.)		
d)	Minor structural defects (e.g. minor corrosion and minor spalling, etc.)		
e)	Non-structural defects		

[D] 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

		Y	NA
9.	**Exposure to aggressive environment:**		
a)	Column immersed in water (e.g. ground floor water tank, seawater, lakes, etc.)		
b)	Aggressive chemicals or other similar substances which may accelerate the deterioration of structural elements, particularly in industrial buildings		
10.	**Slope, Retaining Walls And Slope Protection Structures[E]:**		
a)	Signs of slope erosion		
b)	Defects of retaining wall and other slope protection structures (e.g. cracks, tilt, displacement, etc.)		
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.)		
11.	**Safety Barriers (i.e. parapets & railings):**		
a)	Any signs of structural defect, deformation or deterioration		
b)	Any continuous handrail for full glass barriers		
12.	**Other Surveys Or Checks Carried Out**		
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		
b)	Records of and comments on any known maintenance problems and previous rectification carried out on the building structure.		
13.	**Inspection Coverage**		
a)	Summarised list of units inspected • Percentage of units inspected: _____ %		
b)	At least 30% of cladded columns[F] are exposed for inspection • Percentage of cladded columns[F] exposed: _____ %		
c)	Suspended ceiling accessed points are indicated on a structural/building layout plan		
d)	Justification of inspection coverage		

[E] Examples of slope protection structures are soil nails, ground anchors, shotcrete slope, etc.

[F] 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

	Y	NA
14. Recommended remedial actions for all defects detected		
15. Standard Certification on first and last page of report		

_____ _____

Structural Engineer
For Periodic Inspection of Buildings
(Signature and Stamp)

Date

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:

Y – Yes, I declare that I have checked and addressed the item in my report
N/A – Not applicable, I declare that I have checked and found the item to be not applicable (i.e. does not exist)

	Y	NA
1. Presence of Critical Columns:		
a) Design concrete grade 20		
b) Small-size, narrow, or slender columns[H]		
c) Columns subjected to bi-axial bending or bending about minor axis		
d) Columns unbraced along minor axis.		
e) Void deck used as carpark		
2. Signs of structural defects and deterioration:		
a) Spalling, cracks or deformation		
b) Signs of damage by external force (e.g. vehicular impact)		
c) Signs of differential settlement		
3. Recommendations:		
c) Need for full structural investigation		
d) Need for crash barrier around void deck columns		

_____ _____

Structural Engineer
For Periodic Inspection of Buildings
(Signature and Stamp)

Date

[G] This supplementary checklist is to be used together with 'Annex A - Checklist for Periodic Structural

[H] As a guide, small size or narrow columns are defined as having minimum width less than/ equal to 300mm

EXPLANATORY NOTES TO SUPPLEMENTARY CHECKLIST (Annex B)

1. Structural engineers are to pay special attention to the inspection of small-size, 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) could significantly affect the load capacity.

2. During the inspection of such critical structures, 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.

ANNEX C – CRITERIA FOR COMPLEX BUILDING

A building is deemed to be complex if it consists of one or more of the following:

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);

2) Non-vertical/inclined structural elements (with offset of floor plate more than 3m from the edge of the floor above or below);

3) Structures with unconventional geometry (e.g. dome or arch-shaped); or

4) Large span structures (with span more than 40m) or large cantilever span structures (where cantilever span is more than 8m).

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.

I) AGE

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 undergone major structural improvement/strengthening works, following inspection coverage is recommended for buildings which are >40 years old:

Residential Developments

Age	Percentage of units to be inspected (%)
> 40 years old	40%
> 60 years old	60%

Non-residential Developments

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.

II) CAUSE(S) AND EXTENT OF DEFECT(S) OBSERVED

Depending on the cause and extent of the 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:

A) Signs of distressed structural elements
   - Inspection should be extended to structural elements that may undertake the redistributed loading

B) Corrosion-related defects due to exposure conditions (e.g. corroded rebar, connection or structural steel elements)
   - Inspection should be extended to areas in the building with high humidity, or exposure to aggressive environment. Other areas in the building with similar exposure condition should also be inspected

C) Degradation of building material due to age (e.g. spalled concrete)
   - 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 the building condition.
   - 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

For defects observed and not listed above, due diligence should be exercised by the structural engineer to:

i) assess the additional inspection coverage required, and
ii) justify his/her assessment

III) MAINTENANCE HISTORY OF PAST DEFECTS AND PAST STRENGTHENING WORKS

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:

i) Water leakage at RC roof will have a higher likelihood of spalling concrete occurring than a ceiling slab observed on other floors. Hence, structural engineer is expected to exercise due diligence and carry out simple, appropriate tests (e.g. tapping) at Stage 1: Visual Inspection to detect signs of hollowness.

ii) Improper or incorrect repair of spalling concrete, cracks and holes due to the use of an incorrect repair procedure or unsuitable materials. This will result in the spalling concrete continuing to deteriorate undetected underneath the fresh coats of repair. Hence, the structural engineer is expected to review past repair methodology

ANNEX E – Guidelines for structural inspection for civil engineering structures

(updated as of Sep 2024)

Civil engineering structures being exposed to the elements, especially those submerged in marine environment, are susceptible to accelerated deterioration if they are inadequately maintained. To enable building owners to carry out timely intervention in the form of targeted rectification and strengthening to safeguard the structural integrity of civil engineering structures, building owners of jetties, bridges, underpasses and floating structures will be required to carry out regular PSI.

During inspections of submerged civil engineering structures, the structural engineer should comply with the following requirements:

1) Identify any deviation from intended use, misuse and/or abuse arising from increased mooring or berthing forces from anchoring vessels and ships, heavy lifting equipment or machinery loads, etc.

2) For submerged piles, identify changes to the seabed depth caused by erosion or dredging works that can result in the pile embedment depth to reduce, thus affecting the geotechnical capacity of the pile and the overall stability of the structure it is supporting.

3) All structures both above and below water should be visually inspected with the assistance of divers or Remote Operated Vehicles (ROV) to check for signs of structural defect, deformation, and deterioration. Removal of accumulated marine growth on the surface of structures would be necessary to establish the condition of the structures.

4) For steel members (e.g. steel piles) exposed to marine environment, the rate of corrosion should be examined carefully to check for signs of weakening of the structural integrity of the members due to the reduction in steel thickness. Thickness measurements of steel members at various sections (e.g. top, middle, and bottom of the piles) would be necessary to ensure the rate of corrosion is within the allowable corrosion allowance in relation to the design allowance.

5) Based on the structural condition, the structural engineer should propose any rectifications and strengthening works that may be necessary to ensure safety of the civil engineering structures.