REPUBLIC OF THE UNION OF MYANMAR

COMMITTEE FOR QUALITY CONTROL OF HIGH-RISE BUILDING CONSTRUCTION PROJECTS

GUIDELINES FOR HIGHRISE BUILDING CONSTRUCTION PROJECTS

(STRUCTURE)

August , 2017

COMMITTEE FOR QUALITY CONTROL OF HIGH – RISE BUILDING CONSTRUCTION PROJECTS

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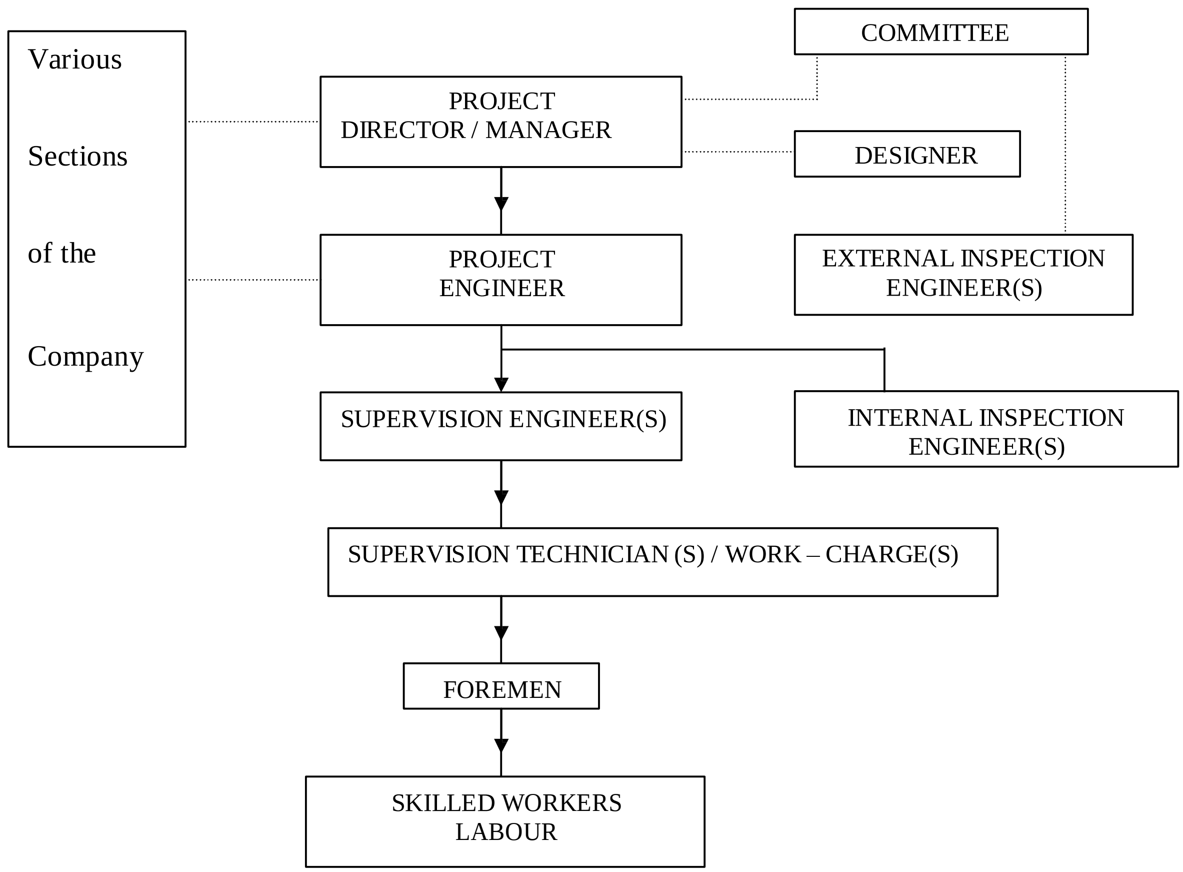
GUIDELINE I

(A) PROJECT ORGANIZATION CHART



COMMITTEE FOR QUALITY CONTROL OF HIGH-RISE BUILDING CONSTRUCTIONPROJECTS
GUIDELINE I

MINIMUM QUALIFICATION REQUIRMENTS FOR VARIOUS POSITIONS

Sr.	DESIGNATION OF POST	QUALIFICATION		
1	Project Director/ Manager	Any graduate preferably with technical education and experiences		
2	Project Engineer	BE (Civil) / 15yrs (or) RSE *	BTech (Civil) / 18 yrs (or) RSE *	AGTI (Civil) / 20 yrs (or) RSE *
3	External Inspection Engineer	BE (Civil) / 15yrs (or) RSE **	BTech (Civil) / 18 yrs (or) RSE **	AGTI (Civil) / 20 yrs (or) RSE **
4	Supervision Engineer/ Internal Inspection Engineer	BE (Civil) / 6yrs (or) RE	BTech (Civil) / 8 yrs (or) RE	AGTI (Civil) / 10 yrs) (or) RE
5	Supervisor / Technician / Work-Charge	Any Graduate / Engineering Diploma		

NOTE

Responsible person for the project shall be PE (Construction).

At least, one RSE (Construction) engineer appointed by the PE (Construction) shall present full time at site.

RSE* = RSE (Construction/ Mechanical (B.S)/ Electrical (B.S)/ Water Supply & Sanitary) in respective field.

RSE** = RSE (Construction/ Structure/ Mechanical (B.S)/ Electrical (B.S)/ Water Supply & Sanitary) in respective field.

RE = RE (Construction/ Structure/ Mechanical (B.S)/ Electrical (B.S)/ Water Supply & Sanitary) in respective field.

Experience means Construction – Related experience after obtaining Degree / Diploma.

The qualification requirements shown in the table are subjected to change when necessary.

COMMITTEE FOR QUALITY CONTROL OF HIGH – RISE BUILDING CONSTRUCTION PROJECTS

GUIDELINE II

GEOTECHNICAL INVESTIGATIONS

1.1 Soil Investigation Report must be submitted to the Committee.

Section 1 : Site location plan

Section 2 : Boring program
(including bore hole location plan, equipment used, sampling, storage and transportation methods, standards used, environmental conditions)

Section 3 : Description of Field Tests
Standard Penetration Test

Section 4 : Description of Laboratory Tests
Natural Water Content Test
Liquid Limit and Plastic Limit Tests
Specific Gravity Test
Triaxial Test (Or Direct Shear Test if the test is compatible with the ground conditions at site)
Unconfined Compressive Strength Test
Grain Size Distribution Test
Other relevant tests must also be performed if required.

Section 5 : Evaluation of test results in consultation with the structural engineer
(including all the detailed calculations mentioned in the Guideline and investigation of liquefaction potential)

Section 6 : Recommendations

Appendices : Field data, Test results, Other data, Diagrams, Sources of literature, etc.

Note

If necessary, structural designer should consult during the period of soil investigation.

1.2 Number of Boreholes and Depth of Boring, Borehole Locations

1.2.1. Number of Boreholes

1. Up to 1000 m^2, minimum no. of boreholes shall be one borehole / 250 m^2 of projected building area but not less than two holes.
2. If the projected area is more than 1000 m^2
   - for the first 1000 m^2 , follow 1.
   - for additional area, no. of additional boreholes shall be one borehole/5,00 m^2 of projected building area.

For irregular soil and terrain conditions, no. of additional boreholes will be decided through consultation between structural engineer and geotechnical consultant.

1.2.2. Depth of Boring

1. For shallow foundations,

   At least 1.5 times lesser dimension of footing, but not less than 10m.

2. For deep foundations,

   Use the following equation to determine the minimum depth of boring:

   $Z = 5\ S^{0.7}$ to $6\ S^{0.7}$ (m), depends on type of structural system and soil condition.

   Where, S is the number of storeys including basement.

However, boring shall not be terminated until minimum SPT value for the last three consecutive is 100. Depth of borehole shall be 3m deeper than pile design depth. The borehole depth shall be specified by structural engineer and geotechnical engineer. If the depth givern by above guideline is more than the capability of the boring machine or for special conditions, consult with the structural engineer.

1.2.3. Borehole Location

1. Boreholes shall be located near building perimeter and building center.
2. Borehole location plan shall be submitted and taken approval from CQHP before boring.

1.3 Minimum requirements of Soil Investigation Report for Deep Excavation Case

Field Test

1. Boreholes spacing may vary from site to site but generally be at intervals of 10m - 30m along the length of the wall. Borehole intervals should depend on soil condition.
2. Standpipe or piezometers should be installed to determine and confirm the ground water conditions at site.
3. SI report for structures with 3 basements and more (or) with total depth of basements 12m and above shall include the permeability test for dominant soil layers to consider the seasonal fluctuation of ground water.
4. Pressure meter or elastmeter measurement should be done on projects which include 3 basements and more (or) with total depth of basements 12m and above to determine of E value.

Laboratory Test

1. Particles size distribution shall be taken by sieve analysis and hydrometer test, etc.
2. Atterberg limits tests shall be done to determine liquid limit, plastic limit, plasticity index and if necessary (swell test).
3. Moisture content, unit weight, specific gravity shall be tested.
4. Direct shear test or Triaxial Test shall be done according to soil nature to determine shear strength.
5. Isotropic Consolidated Undrained Triaxial Test with pore water pressure measurements shall be done for structures with 3 basements and more (or) with total basements depth 12m and above.
6. Unconfined Compression Strength Test (UCS) and Consolidation Test shall be done for cohesive soil.

Remarks:

- The above mentioned tests should be carried out at the boreholes along the wall.
- Determination of seepage pressure should be done case by case only.
- In-situ permeability test should be done for structures with 3 basements and more.
- Borehole sample shall be taken 1.8m interval for up to 10m borehole depth and 3m interval from 10m to end of boring.

1.4 Pile Load Test

Pile load test must be performed with the approval of the Committee. The pile load test must be taken and follow according to ASTM D-1143 specification.

A. Minimum Number of Pile Load Tests

Bored Piles

- Instrumental / Ultimate Load Test	- 1 No
- Working Load Test	- 1 % of Total Number of Bored Piles
- Integrity Test	- 50 % of Total Number of Bored Piles

Driven Piles

- Working Load Test	- 1 % of Total Number of Piles
- Integrity Test	- 50% of Total Number of Piles

Jacked-in Pile

-Working Load Test	- 1% of Total Number of Pile for up to500 nos. If number of pile is more than 500 in one building, 0.5% shall be conducted for the rest of piles.
- Integrity Test	- 50% of Total Number of Piles

The location of test pile shall be based on soil profile and structural framing system.

At least 50% of Working Load Test points shall be done by Static Load Test. And the remaining 50% of Working Load Test points can be done by Dynamic Load Test. But the number of Dynamic Load Test Points shall be 3 times of the remaining 50% Working Load Test points. (1 static = 3 dynamic).

Dynamic load test shall be performed at site where the adjacent buildings will not be affected and need to study the condition of adjacent buildings.

B. Requirements for Ultimate Pile Load Test

The following requirements shall be submitted to CQHP in performing the pile load test.

1. YCDC letter

2. Soil report
3. Pile design
   (a) Design of test pile (structural capacity and geotechnical capacity)
   (b) Design of tension piles (if anchored piles are used)
4. Method statement of pile load test
5. Test pile location plan with borehole locations
6. Architectural conceptual drawings

C. Requirements for Working Pile Load Test

The following requirements shall be submitted to CQHP in performing the pile load test.

1. YCDC letter
2. Soil report
3. Column loading calculation
4. Structural analysis and design software
5. Pile design
   (a) Design of test pile (structural capacity and geotechnical capacity)
   (b) Design of tension piles (if anchored piles are used)
6. Overall pile layout plan
7. Method statement of pile load test
8. Test pile location plan with borehole locations
9. Architectural drawings

D. Instructions for Performing the Pile Load Tests

1. The minimum C/C spacing of all working piles shall be 2.5 times of pile diameter.
2. In performing the ultimate pile load test, the minimum C/C spacing between test pile and anchor pile shall be 3 times of larger pile diameter.
3. In performing the working pile load test, the minimum C/C spacing between test pile and anchor pile shall be 2.5 times of larger pile diameter.
4. Structural tension capacity of anchor pile reinforcement shall be 0.6 f_y.
5. Safety factor for geotechnical tension capacity of anchor pile shall be 3.
6. If the whole system is calibrated, the pile load test can be performed without load cell.

7. The calibrated time of load cell, hydraulic jack, pressure gauges & pressure transducers, dial gauge, level instrument and linear vibration displacement transducers (LVDT) shall be within 6 months.
8. Should there be any changes from the load test pile installation company and the remaining pile installation company, consulting with CQHP is necessary.

E. Guide Lines on Pile Load Test

Any one of the following three methods on Pile Load Test can be selected and used, and duly submitted to the CQHP for approval.

Method (1) To conduct, first the ultimate Load Test with the approval of CQHP and submit report of the test results for evaluation to the CQHP. The remaining working load test shall be continued following acceptance of the test result, and inspection on piling work to be made only after the pile capacity is fully attained.

Method (2) Both the Ultimate Load Test and the working load test can be conducted simultaneously with the approval of the CQHP. However the full responsibility of the remaining piling works shall be borne entirely by the company and the designer which shall be conducted in advance of the piling operation.

Method (3) Before commencing the operation on the ULT and the WLT. Pile works can be conducted in advance with the full responsibility of both the company and the designer. Out of the piles works thus completed, CQHP will select which of the pile to undergo the ULT and the WLT with given instruction.

Note

(1) The CQHP shall be duly informed of the method by which the piling test will be conducted before any work has begun on piling.

(2) If the required pile capacity cannot be attained, when either method 2 or 3 in followed, the piling layout, as laid down by the company and designer, shall be adjusted as required with respect to the value of the capacity obtained. This task work shall be undertaken by the company and the designer which the assurance and the pledge that all requirements will be daily fulfilled.

1.5 Calculations of Bearing Capacity and Pile Capacity or Pile Group Capacity

1.5.1 Allowable Bearing Capacity Calculation for Mat Foundation Design

1. Nearest borehole data should be used for the bearing capacity calculation of mat foundation.
2. Bearing capacity can be determined by using minimum value from the calculation by (a) SPT value method and (b) C, ø value method.
3. State clearly the parameters considered in calculating bearing capacity for mat foundation design and explain how the parameters are found.

1.5.2 Pile Capacity or Pile Group Capacity Calculation for Pile Foundation Design

A. Pile Structural Capacity

1. Cylinder strength of concrete shall be 30Mpa (f'_c = 30 Mpa) for structural capacity calculation of working pile. Cylinder strength of concrete used in pile construction shall be increased from 30Mpa to 35Mpa.
2. Cylinder strength of concrete shall be 35Mpa (f'_c = 35 Mpa) for structural capacity calculation of ultimate pile. Cylinder strength of concrete used in pile construction shall be increased from 35Mpa to 40Mpa.

B. Pile Geotechnical Capacity

1. Pile geotechnical capacity shall be determined by using minimum value from the calculation by (a) SPT value method and (b) C, ø value method.
2. State clearly the parameters considered in calculating pile capacity for a pile or a pile-group design and explain how the parameters are found.

1.6 Minimum Reinforcement for Bored Pile

(a) For Seismic Zone 2A and 2B

(i) Pile diameter (D) less than or equal 800 mm : Longitudinal steel shall be provided for a length not less than 10 m from pile cap soffit level, with a minimum steel ratio of 1 % of pile cross sectional area .The longitudinal reinforcement beyond the top 10 m, steel shall be provided with a minimum steel ratio of 0.5 % of pile cross sectional area through the length of pile. If the soil is liquefied, reinforcement length shall extend 3D below the liquefiable strata, with minimum steel ratio of 1 % of pile cross sectional area. Beyond the liquefiable strata, the minimum steel ratio of 0.5% of pile cross sectional area through the length of pile shall be provided.

(ii) Pile diameter (D) greater than 800 mm : Longitudinal steel shall be provided for a length not less than 10 m from pile cap soffit level, with a minimum steel ratio of 0.8 % of pile cross sectional area .The longitudinal reinforcement beyond the top 10 m, steel shall be provided with a minimum steel ratio of 0.4 % of pile cross sectional area through the length of pile. If the soil is liquefied, reinforcement length shall be extend 3D below the liquefiable strata, with minimum steel ratio of 0.8% of pile cross sectional area. Beyond the liquefiable strata, the minimum steel ratio of 0.4% of pile cross sectional area through the length of pile shall be provided.

(b) For Seismic Zone 3 and 4

(i) Longitudinal steel shall be provided for a length not less than 10 m from pile cap soffit level, with a minimum steel ratio of 1 % of pile cross sectional area .The longitudinal reinforcement beyond the top 10 m, steel shall be provided with a minimum steel ratio of 0.5 % of pile cross sectional area through the length of pile. If the soil is liquefied, reinforcement length shall extend 3D below the liquefiable strata, with minimum steel ratio of 1% of pile cross sectional area. Beyond the liquefiable strata, the minimum steel ratio of 0.5% of pile cross sectional area through the length of pile shall be provided.

(c) For minimum yield strength of longitudinal reinforcement, (f_y) shall be 50000 psi. For transverse reinforcement, (f_y) shall be minimum of 40000 psi.

(d) For bored piles less than 0.8 m diameter, minimum 16 mm diameter rebar shall be used.

(e) For bored piles greater than or equal to 0.8 m diameter, minimum of 20 mm diameter rebar shall be used.

(f) Minimum number of rebar shall be 6 Nos.

(g) Minimum 10 mm diameter transverse reinforcement shall be provided at lesser spacing of 16-longitudinal-bar diameter or 12 inches. Transverse confinement reinforcement with a maximum spacing of 6 inches (152 mm) or 8- longitudinal-bar diameters, whichever is less, shall be provided within a distance equal to three times the least pile dimension from the bottom of the pile cap.

1.7 Liquefaction Analysis

Geotechnical report shall include liquefaction analysis by using any acceptable methods, one of which is stated below.

Step 1: The first step is to determine the Seismic Shear Stress Ratio (SSR).SSR induced by the earthquake at any point in the ground is estimated by

$$SSR = 0.65\, r_d \left(\frac{a_{max}}{g}\right) \left(\frac{б_{vo}}{б'_{vo}}\right)$$

in which;

a_{max} = peak acceleration measured or estimated at the ground surface of the site(m/s^2).

g = acceleration of gravity (9.81 m/s^2)

$б_{vo}$ = total vertical stress at a particular depth, where the liquefaction analysis is being performed

= r_{sat} x z

$б'_{vo}$ = vertical effective stress at that same depth where $б_{vo}$ was calculated

= $(r_{sat} - r_w)\, z$

r_{sat} = saturated unit weight of the soil

r_w = unit weight of water

r_d = depth reduction factor

= 1- (0.012) (z)

z = depth in meters below the ground surface where the liquefaction analysis is performed. (the same depth used to calculate $б_{vo}$ and $б'_{vo}$

Step 2: The second step is to determine the Seismic Shear Stress (SSR') that will cause liquefaction of the in situ soil. Fig-1 can be used to determine SSR'. In order to use the fig. SPT $(N_1)_{60}$ must be known. SPT $(N_1)_{60}$ is the corrected SPT N_{60} for the effect of overburden pressure.

$$(N_1)_{60} = C_N \; N_{60} = \left[\frac{100}{\sigma'_{vo}} \right]^{0.5} N_{60}$$

$$N_{60} = 1.67 \; E_m \; C_b \; C_r \; N$$

Where,

N_{60} = SPT N value corrected for the field testing procedure

E_m = hammer efficiency
= 0.6 for a safety hammer (free fall- Auto/Trip)
= 0.45 for a doughnut hammer (Rope and Pulley- Manual)

C_b = borehole diameter correction
= 1.0 for 65 to 115 mm Ø boreholes
= 1.05 for 150 mm Ø boreholes
= 1.15 for 200 mm Ø boreholes

C_r = rod length correction
= 0.75 for up to 4 m of drill rods
= 0.85 for 4 to 6 m of drill rods
= 0.95 for 6 to 10 m of drill rods
= 1.00 for > 10 m of drill rods

N = measured SPT N value

$(N_1)_{60}$ = N value corrected for both field testing procedure and overburden pressure

C_N = correction factor to account for overburden pressure

$$= \sqrt{\frac{100}{\sigma'_{vo}}}$$

where σ'_{vo}= effective overburden pressure in (KPa)

Step 3 : The final step in the liquefaction analysis is to compare the Seismic Shear Stress Ratio values. If the SSR values is greater than the SSR′ values obtained from Fig 1 or Fig 2 then liquefaction could occur during the earthquake, and vice versa.

Note

Other analysis methods for Liquefaction Potential can be presented for comparison.

COMMITTEE FOR QUALITY CONTROL OF HIGH – RISE BUILDING CONSTRUCTION PROJECTS

GUIDELINE III

STRUCTURAL DESIGN

3.1 General Requirements

1. Every page of the structural drawing sheets shall be signed by PE (structure). Structural calculation sheets can be stamped by PE (Structure).
2 .The design calculation sheets shall be properly bound using ring binders and the pages shall be numbered consecutively.
3. Where a computer program is used, the name, assumptions and limitations of the program shall be explained first and the inputs and the outputs thereof shall be clearly mentioned as part of the design calculations.
4. The design calculations shall be accompanied by one copy of soil investigation report, the computations of the soil bearing capacity and where applicable, the consideration of negative skin friction of piles. Mention clearly the method used in the calculation and the literature referred to for the interpretation.
5. ACI 318-99 (or later versions) is recommended for reference in the design of reinforced concrete members. Strength design method or working-stress design method can be used.
6. AISC Specifications is recommended for the design of steel members. LRFD (Load Resistance Factor Design) method or working- stress design method can be used but the code referred to shall not be earlier than 1989.

3.2 Structural Design Requirements

1. All dead loads shall be taken into account.
   Minimum superimposed dead load = 20 psf for finishing
   Minimum superimposed dead load = 10 psf for light partition
   Minimum superimposed dead load = 50 psf for $4^1/_2$ " thick brick wall and
   Minimum superimposed dead load = 100 psf for 9 " thick brick wall.
2. Live loads shall be considered in accordance with the values given in the tables attached (Table-A, Table-B, Table-C).

3. Wind load shall be considered according to UBC -97 / ASCE / IBC / MNBC. Basic wind speed shall be 100 mph for Yangon region.
4. Earthquake load shall be taken into consideration according to UBC -97 / ASCE / IBC / MNBC. (Yangon-Zone IIB and Mandalay-Zone IV can be accepted). Storey range for seismic load case in structural model should be assigned from ground floor to roof top whether basements are included or not.
5. All load combinations in compliance with relevant design codes of practice shall be taken into consideration. Combinations accepted by CQHP, those given in Table (D), can also be used for structural member analysis.
6. The loads acting on the structure or the structural member which is being analyzed or designed shall be clearly mentioned (diagrammatically wherever necessary) for easy checking and reference.
7. Methods of analysis should be in accordance with those specified in relevant codes. However, considering the existing circumstances, those given in Table (E) may also be used as a minimum requirement.
8. The axial force, bending moment and shear force for every structural member shall be computed and submitted. Torsion and deflection shall also be computed and submitted for critical members.
9. Reinforcement and size of every structural member shall be properly designed. Reinforce the members and joints to make ductile frames.
10. Identification of structural elements in design calculations shall be the same as those shown on the architectural and structural plans.
11. The Codes used, design strengths of materials used, other specifications and assumptions shall be clearly stated in the beginning (and wherever necessary) of the design calculation sheets and also on the structural plans.
12. Detailed structural plans shall include:
    (a) all structural elements and structural frameworks,
    (b) details of joints and connections,
    (c) details of reinforcements and
    (d) technical notes on construction sequence when phased construction affects design

13. In the foundation design, the effect of earthquake shall be considered.
14. In the foundation design, considerations shall be also given to the probable differential and total settlement of the buildings.
15. ETABS, STAAD PRO, SAP 2000, SAFE, ADAPT software, etc. can be used for structural analysis and design.

3.3 Instruction for Structure

3.3.1 Design of Slab

1. Slab type shall be assigned as shell or membrane in normal slab.
2. Flat plate and ramp slab shall be assigned as shell.
3. Precast slab shall be assigned as membrane.
4. Lateral force shall be considered in slab design.

3.3.2 Design of Transfer Structure

If the transfer plate is provided in the structure, the instructions for transfer plate design are as follows:

1. $R \leq 4$
2. Structural Period (T) = 0.025 H_b
   H_b = Building Height (meter)
3. Over-strength Factor (Ω_0) to use in transfer beam/plate and supporting column design and two storey above the transfer plate.
4. Weak Story Check.
5. Soft Story Check.
6. Storey Stiffness ratio
   $(\Delta_1/H_1)/(\Delta_2/H_2) \leq 1.3$
   H_1 = Height of the substructure below the transfer plate
   H_2 = Height of the substructure above the transfer plate similar to but not taller than H_1 for stiffness ratio calculation.
   Δ_1 = Lateral deformation of substructure below the transfer plate
   Δ_2 = Lateral deformation of substructure above the transfer plate

7. Beams, columns and walls shall be designed as per special moment resisting frame requirements.
8. Transfer level should not be more than one.
9. To analysis and design of transfer plate by considering local deformation of transfer plate.
10. To perform dynamic analysis.
11. To perform construction sequence analysis.
12. Transfer plate location must be under 1/3 height of the building.
13. Long term cracked deflection of the transfer plate shall not be more than 20 mm.
14. To provide method statement for transfer plate construction.

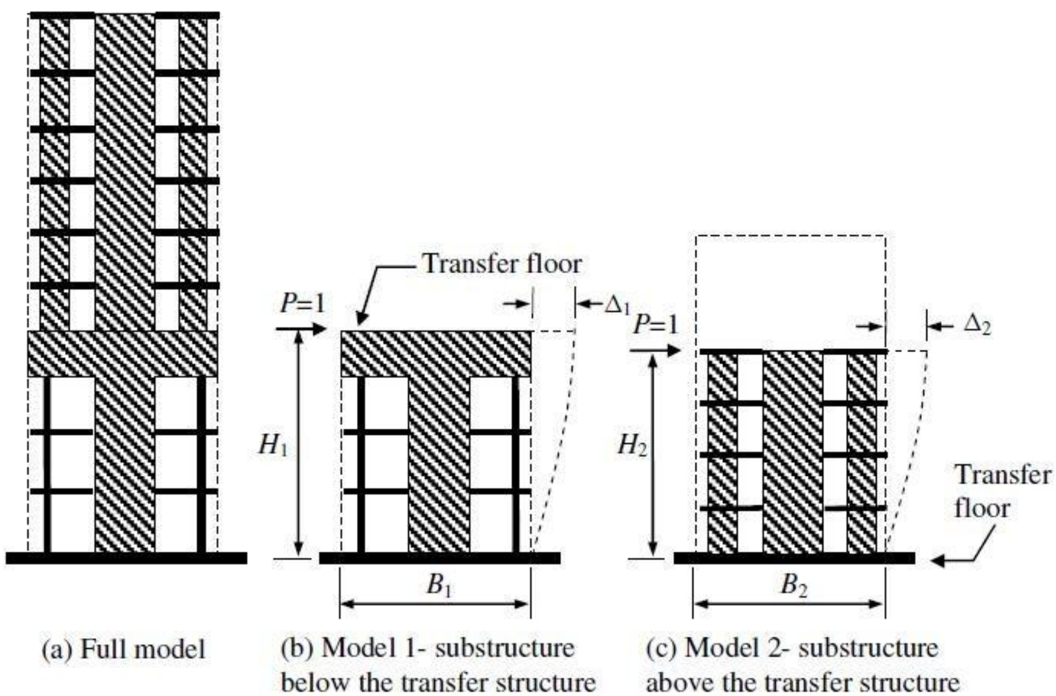


Figure. Numerical models for calculating the equivalent stiffness below and above the transfer structure

3.3.3 Design of Flat Slab and Flat Plate

If the flat slab and flat plate are provided in the structure, the instructions for flat slab and flat plate design are as follows:

1. Maximum drift limit = 0.015h (for Flat Plate and Flat Slab)
2. Reference codes (Unless otherwise defined)
   - ACI 318 – 08
   - IBC 2006
   - ACI 352.1R
   - ACI 352.2R – 02
   - ACI 421.2R – 10

3. Analysis method

   Dynamic analysis (Seismic Spectrum Method) should be done as per code requirements.

4. Perimeter beams
   - At perimeter of structure
   - At perimeter of staircases
5. Openings in slabs
   - To be considered in design stage as accurate as possible according to requirements of building services.
   - To provide special reinforcements around slab openings (Provide beams if necessary)
6. Special remarks
   - Slab - Column, Beam – Column connections must be designed according to the relevant ACI codes considering seismic load.
   - P – Δ analysis also must be carried out
   - As the flat plate is weak in seismic resistance, care must be taken in design stage and especially in construction stage also.
   - To consider seismic load in selecting the appropriate building configuration.

3.3.4. Design of Postension Slab

1. Post tension slab design and method statement should be submitted from the post tension company.

3.4 Retaining Walls

All earth retaining structures should be designed to meet the requirements of any recognized codes for Earth Retaining Structures.

1. If CBP or diaphragm wall include, lateral pressure should be assigned at floor. Only water pressure should be assigned on skin wall.
2. If CBP or diaphragm wall does not include, lateral pressure should be assigned on skin wall.

3.5 Alterations, Additions or Minor Works

An alteration to the original design must be informed together with all supporting design calculations well ahead of the actual construction of the altered parts.

TAB LE (A) MINIMUM UNIFORM AND CONCENTRATED LOADS

USE OR OCCUPANCY		UNIFORM LOAD [1] (pounds per square foot)	CONCENTRATED LOAD (pounds)
Category	Description	x 0.0479 for KN/m^2	x 0.00448 for KN
1. Access floor systems	Office use	50	2,000 [2]
	Computer use	100	2,000 [2]
2. Armories		150	0
3. Assembly areas and auditoriums and balconies therewith 3	Fixed seating areas	50	0
	Moveable seating and other areas	100	0
	Stage areas and enclosed platforms	125	0
4. Corncies and marquees		60	0
5. Exit facilifies [4]		100	0 [4]
6. Garages	General storange	100	0 [2]
	Private or pleasure type motor vehicle storage	50	0 [2]
7. Hospitals	Wards and rooms	40	1000 [2]
8. Libraries	Reading rooms	60	1,000 [2]
	Stack rooms	125	1,500 [2]
9. Manufacturaing	Light	75	2,000 [2]
	Heavy	125	3,000 [2]
10. Offices		50	2,000 [2]
11. Printing plants	Press rooms	150	2,500 [2]
	Composing and linotype rooms	100	2,000 [2]
12. Residential [6]	Basic	40	0 [5]
	Exterior balconies	60	0
	Decks	40	0
13. Restrooms [7]			
14. Reviewing stands, grandstands bleachers, and folding and telescoping seating		100	0
15. Roof decks	Same as area served or for the type of occupancy accommodated		
16. Schools	Class rooms	40	1,000 [2]
17. Sidewalks and driveways	Public access	250	
18. Storage	Light	125	
	Heavy	250	
19. Stores		100	3,000 [2]
20. Pedestrian bridges and walkways		100	
21. Vehicle gross weight (3 tons max;)	Parking area live load	60	3000 $(4.5 \times 4.5)in^2$
	Driveway outside carparking area loading or Ramp loading	120	3000 $(4.5 \times 4.5)in^2$
Note: Entrance height shall be limited to 2.2 m (7'-3").			

1. See “Reduction of live load”.
2. See “Concentrated loads”.
3. Assembly areas include such occupancies as dance halls, drill rooms, gymnasiums, playgrounds, plazas, terraces and similar occupancies which are generally accessible to the public.
4. Exit facilities shall include such uses as corridors serving an occupant load of 10 or more persons, exterior exit balconies, stairways, fire escapes and similar uses.
5. Individual stair treads shall be designed to support a 300-pound (1.33 KN) concentrated load placed in a position which would cause maximum stress. Stair stringers may be designed for the uniform load set forth in the table.
6. Residential occupancies include private dwellings, apartments and hotel guest rooms.
7. Restroom loads shall not be less than the load for the occupancy with which they are associated, but need not exceed 50 pound per square foot (2.4 KN/m^2).

Reduction of Live Load

The design live load determined using the unit live loads as set forth in Table A for floors may be reduced on any member supporting more than 150 square feet, including flat slabs, except for floors in places of public assembly for live loads greater than 100 pounds per square foot, in accordance with the following formula:

$$R = r\,(A - 150)$$

The reduction shall not exceed 40 percent for members receiving load from one level only, 60 percent for other members, or R as determined by the following formula:

$$R = 23.1(1 + D/L)$$

where:

A = area of floor supported by the member, square feet

D = dead load per square foot of area supported by the member

L = unit live load per square foot of area supported by the member

R = reduction in percentage

r = rate of reduction equal to 0.08 percent for floors

For storage live loads exceeding 100 pounds per square foot, no reduction shall be made, except that design live loads on columns may be reduced 20 percent.

The live load reduction shall not exceed 40 percent in garages for the storage of private pleasure cars having a capacity of not more than nine passengers per vehicle.

Alternative Floor Live Load Reduction

As an alternative to the above formula, the unit live loads set forth in Table A may be reduced in accordance the following formula on any member, including flat slabs, having an influence area of 400 square feet or more,

$$L = L_0\ (0.25\ \sqrt{A_1}\ )$$

where:

A_I = influence area, in square feet. The influence area A_I is four times the tributary area for a column, two times the tributary area for a beam, equal to the panel area for a two-way slab, and equal to the product of the span and the full flange width for a precast T-beam

L = reduced design live load per square foot of area supported by the member

L_0 = unreduced design live load per square foot of area supported by the member (Table A)

The reduced live load shall not be less than 50 percent of the unit live load L_0 for members receiving load from one level only, not less than 40 percent of the unit live load L_0 for other members.

Concentrated Loads

Provision shall be made in designing floors for a concentrated load as set forth in Table-A placed upon any space 2½ feet square, wherever this load upon an otherwise unloaded floor would produce stresses greater than those caused by the uniform load required therefor.

Provision shall be made in areas where vehicles are used or stored for concentrated loads consisting of two or more loads spaced 5 feet nominally on centers without uniform live loads. Each load shall be 40 percent of the gross weight of the maximum-size of vehicle to be accommodated. The condition of concentrated or uniform live load producing the greater stresses shall govern. Parking garages for the storage of private or pleasure-type motor vehicles with no repair or refueling shall have a floor system designed for a concentrated load of not less than 2,000 pounds acting on an area of 20 square inches without uniform live loads. The condition of concentrated or uniform live load producing the greater stresses shall govern.

Provision shall be made for special vertical and lateral loads as set forth in Table-B.

TABLE (B) SPECIAL LOADS[1]

USE		VERTICAL LOAD	LATERAL LOAD
Category	Description	(pounds per square foot unless otherwise noted)	
		x0.0479 for KN/m^2	
1. Construction, public access at site (live load)	Walk way	150	
	Canopy	150	
2. Grandstands, reviewing stands bleachers, and folding and telescoping seating(live load)	Seats and footboards	120 [2]	See Footnote 3
3. Stage accessories(live load)	Catwalks	40	
	Follow spot, projection and control rooms	50	
4. Ceiling framing (live load)	Over stages	20	
	All use except over stages	10 [4]	
5. Elevators and dumbwaiters (dead and live loads)		2x total load	
6. Mechanical and electrical equipment (dead load)		Total loads	
7. Cranes (dead and live load)	Total load including impact increase	1.25 x total load [5]	0.10 x total load [6]

1. The tabulated loads are minimum loads. Where other vertical loads required by this code or required by the design would cause greater stresses, they shall be used.
2. Pounds per lineal foot (x 14.6 for N/m).
3. Lateral sway bracing loads of 24 pounds per foot (350 N/m) parallel and 10 pounds per foot (145.9 N/m) perpendicular to seat and footboards.
4. Does not apply to ceilings which have sufficient total access from below, such that access is not required within the space above the ceiling. Does not apply to ceilings if the attic areas above the ceiling are not provided with access. This live load need not be considered as acting simultaneously with other live loads imposed upon the ceiling framing or its supporting structure.
5. The impact factors included are for cranes with steel wheels riding on steel rails. They may be modified if substantiating technical data acceptable to the building official is submitted. Live loads on crane support girders and their connections shall be taken as the maximum

crane wheel loads. For pendant operated traveling crane support girders and their connections, the impact factors shall be 1.10.

6. This applies in the direction parallel to the runway rails (longitudinal). The factor for forces perpendicular to the rail is 0.2 x the transverse traveling loads (trolley, cab, hooks and lifted loads). Forces shall be applied at top of rail and may be distributed among rails of multiple rail cranes and shall be distributed with due regard for lateral stiffness of the structures supporting these rails.

TABLE (C) MINIMUM ROOF LIVE LOADS[1]

Roof Slope	METHOD 1		
	Tributary Loaded Area in Square Feet for Any Structural Member		
	x0.0929 for m^2		
	0 to 200	201 to 660	Over 600
	Uniform Load (Ponds per square foot)		
	x 0.0479 for KN/m^2		
1. Flat[2] or rise than 4 units vertical in 12 units horizontal (33.3% slope). Arch or dome with rise less than one eight of span.	20	16	12
2. Rise 4 units vertical to less than 12 units vertical in 12 units horizontal (33% to less than 100% slope). Arch or dome with rise one eight of span to less than three eights of span.	16	14	12
3. Rise 12 units vertical in 12 units horizontal (100% slope) and greater. Arch or dome with rise three eights of span or greater.	12	12	12

1. See Reduction of live loads.
2. A flat roof is any roof with a slope of less than ¼ unit vertical in 12 units horizontal (2% slope). The live load for flat roofs is in addition to eh ponding load.

TABLE (D) Sample Load Combination For ACI 318-99 and UBC-97 Under Static Analysis

Factor Load Combination		Unfactor Load Combination	
1	1.4 D	1	D
2	1.4 D + 1.7 L	2	D + L
3	1.05 D + 1.275 L + 1.275 WX	3	D + WX
4	1.05 D + 1.275 L - 1.275 WX	4	D - WX
5	1.05 D + 1.275 L + 1.275 WY	5	D + WY
6	1.05 D + 1.275 L - 1.275 WY	6	D - WY
7	0.9 D + 1.3 WX	7	D + 0.714 EQX
8	0.9 D - 1.3 WX	8	D - 0.714 EQX
9	0.9 D + 1.3 WY	9	D + 0.714 EQY
10	0.9 D - 1.3 WY	10	D - 0.714 EQY
11	1.05 D + 1.28 L + EQX	11	0.9 D + 0.714 EQX
12	1.05 D + 1.28 L - EQX	12	0.9 D - 0.714 EQX
13	1.05 D + 1.28 L + EQY	13	0.9 D + 0.714 EQY
14	1.05 D + 1.28 L - EQY	14	0.9 D - 0.714 EQY
15	0.9 D + 1.02 EQX	15	D + 0.75 L + 0.75 WX
16	0.9 D - 1.02 EQX	16	D + 0.75 L - 0.75 WX
17	0.9 D + 1.02 EQY	17	D + 0.75 L + 0.75 WY
18	0.9 D - 1.02 EQY	18	D + 0.75 L - 0.75 WY
19	1.19 D + 1.28 L + EQX	19	D + 0.75 L + 0.54 EQX
20	1.19 D + 1.28 L - EQX	20	D + 0.75 L - 0.54 EQX
21	1.19 D + 1.28 L + EQY	21	D + 0.75 L + 0.54 EQY
22	1.19 D + 1.28 L - EQY	22	D + 0.75 L - 0.54 EQY
23	0.757 D + 1.02EQX		
24	0.757 D - 1.02EQX		
25	0.757 D + 1.02EQY		
26	0.757 D - 1.02EQY		

Where,

DL	= Dead Load
LL	= Live Load
WX	= Wind Load in X- direction
WY	= Wind Load in Y- direction
EQX	= Earthquake Load in X- direction
EQY	= Earthquake Load in Y- direction

Note

These load combinations accepted by CQHP are combinations applied by ACI 318 - 99 and UBC - 97. If other ACI 318 versions are used, load combinations should be changed accordingly.

TABLE (E) ACCEPTABLE ANALYSIS METHOD FOR STRUCTURAL DESIGN

Building Type	**Zone III to V**		**Zone I & II**	
	Building Height > 240 ft	Building Height ≤ 240 ft	Building Height > 240 ft	Building Height ≤ 240 ft
Regular Building	Three-dimensional Dynamic Analysis	Three-dimensional Dynamic Analysis	Three-dimensional Dynamic Analysis	Three-dimensional Static Analysis
Irregular Building	Three-dimensional Dynamic Analysis	Three-dimensional Dynamic Analysis	Three-dimensional Dynamic Analysis	Three-dimensional Dynamic Analysis

COMMITTEE FOR QUALITY CONTROL OF HIGH-RISE BUILDING CONSTRUCTION PROJECTS

ANNEX I TO GUIDELINE III

KEY POINTS WHICH SHALL BE CHECKED BY CQHP AND MUST BE CONSIDERED AND MENTIONED BY THE STRUCTURAL ENGINEER

Project Title --

Project Reference No: --------------------------------------- Date ---

OVERAL DESIGN REVIEW TASKS

(I) Codes of Practice

(II) Specifications of Materials Used

- Design strength of concrete, steel etc
- Soil Investigation Report

(III) Design Loadings

- Loading used in the design
- Load combinations used in the design

(IV) Structural Design Concept

- Structural system used

(V) Structural Analysis

- Engineering information and models used in the analysis
- Design assumptions and limitations of the computer programs used

(VI) Stability & Robustness

- Stability and robustness of the structural system, including considerations for lateral loads, lateral ties, bracings and lateral transfer of loads

(VII) All Key Structural Elements

- Design of all key structural elements and the foundation system

(VIII) Structural Drawings

- Detailing in drawing of all key structural elements
- Consider ductile detailing

(IX) Other Aspects in Design

- Other aspects of design which are peculiar to the building to be constructed or affected by the building works and which are essential to the structural integrity of the building.

COMMITTEE FOR QUALITY CONTROL OF HIGH-RISE BUILDING CONSTRUCTION PROJECTS

ANNEX II TO GUIDELINE III

FORMAT FOR DESIGN CALCULATIONS REPORT

PART (A) FOUNDATION

Section 1 : Design Parameters and Assumptions

Section 2 : Loadings and load Combinations

Section 3 : Structural Systems

All plans and sections in both directions (including assumed member sizes for the final run)

Section 4 : Input Data

Section 5 : Output Data

(Important or significant results only)

Section 6 : Detailing of Foundation Reinforcement

Note

All the details involved in the analysis and design processes must be submitted in CD.

PART (B) SUPERSTRUCTURE

Section 1 : Design Parameters and Assumptions

Section 2 : Loadings and Load Combinations

Section 3 : Structural Systems

All plans and sections in both directions (including assumed member sizes for the final run)

Section 4 : Input Data

Section 5 : Output Data

(Important or significant results only)

Section 6 : Member Type Grouping Tables

Section 7 : Detailing of Reinforcement

Note

All the details involved in the analysis and design processes must be submitted in CD.

COMMITTEE FOR QUALITY CONTROL OF HIGH-RISE BUILDING CONSTRUCTION PROJECTS

ANNEX (III) TO GUIDELINE III

FORMAT FOR STRUCTURAL DRAWING

Section 1 : List of drawings.

Section 2 : Every sheet shall be numbered clearly.

Section 3 : PE (Structure) shall sign on all drawing sheets.

Section 4 : Drawing size shall be A3 (minimum). Suitable and readable drawing scale shall be used.

Section 5 : Specifications of materials and required instructions shall be shown on the drawings.

Section 6 : Final design sections and reinforcements given by the software shall be printed and submitted in the design calculation report.

Section 7 : Seismic detailing corresponding to SMRF, IMRF or OMRF (as the case may be) shall be strictly followed according to ACI, UBC and MNBC.

Section 8 : The same grid line numbering shall be used by both Architectural and Structural Drawings.

Section 9 : Detail drawing of all different structure members shall be submitted.

Note

All the details involved in the analysis and design processes must be submitted in CD.

COMMITTEE FOR QUALITY CONTROL OF HIGH – RISE BUILDING CONSTRUCTION PROJECTS

GUIDELINE IV

SUBMISSION DOCUMENT CHECKLIST

4.1 Checklist for Ultimate Pile Load Test

SUBMISSION DOCUMENT CHECK-LIST		**STRUCTURAL**	**PILE LOAD TEST**	**SD-SP**
PID			Submitted by	Received By
Project		Name		
Developer		Designation		
Date		Contact No.		
(Note: To be completed by designer / responsible personnel.)		Signature		
Main Subject	Particular		Checked	Remark
	Ultimate Pile Load Test			
SP1 Pile Load Test	SP1.1 Letter From YCDC			
	SP1.2 Code of Practice and Design Reference			
	SP1.3 Method of Statement of Pile Load Test			
	SP1.4 Material Properties			
	SP1.5 Pile Design Report by Foundation Designer			
	SP1.6 Architectural Drawing (Conceptual)			
	SP1.7 Geotechnical Report (should consist adequate c, Φ and SPT value for pile design calculation) and Bore Hole Profile			
	SP1.8 Site Location Plan with adjacent building and bore holes			
	SP1.9 Ultimate test pile location plan			
	SP1.10 Test pile details (Anchor pile details if anchor method)			

SP2 Submission Set	SP2.1 Signatures	SP2.1.1 Local Design: Signature of Professional Engineer (Geotechnical)		
		SP2.1.2 Foreign Design: Signature of Original Geotechnical Design Engineer		
		SP2.1.3 Foreign Design: Signature of National Counter Part (PE)		
	SP2.2 Document Set	SP2.2.1 CD for Design Drawing , Calculation and Report - 2 sets		
		SP2.2.2 Design Report - 4 sets		
		SP2.2.3 Design Calculation - 4 sets		
		SP2.2.4 Design Drawings - 4 sets		

4.2 Checklist for Working Pile Load Test

SUBMISSION DOCUMENT CHECK-LIST			**STRUCTURAL**	**PILE LOAD TEST**	**SD-SP**
PID				Submitted by	Received By
Project			Name		
Developer			Designation		
Date			Contact No.		
(Note: To be completed by designer / responsible personnel.)			Signature		
Main Subject	Particular Working Pile Load Test			Checked	Remark
SP1 Pile Load Test	SP1.1 Code of Practice and Design Reference				
	SP1.2 Method of Statement of Pile Load Test				
	SP1.3 Material Properties				
	SP1.4 Pile Design Report by Foundation Designer (Geotechnical and Structural Design)				
	SP1.5 Geotechnical Report (should consist adequate c, Φ and SPT value for pile design calculation) and Borehole Profile				
	SP1.6 Site Location Plan with adjacent building and bore holes				
	SP1.7 Columns loading calculation				
	SP1.8 Piling Plan with Test Pile Locations				
	SP1.9 Test pile details (Anchor pile details if anchor method)				
SP2 Submission Set	SP2.1 Signatures	SP2.1.1 Local Design: Signature of Professional Engineer (Geotechnical)			
		SP2.1.2 Foreign Design: Signature of Original Geotechnical Design Engineer			
		SP2.1.3 Foreign Design: Signature of National Counter Part (PE)			
	SP2.2 Document Set	SP2.2.1 CD for Design Drawing , Calculation and Report - 2 sets			
		SP2.2.2 Design Report - 4 sets			
		SP2.2.3 Design Calculation - 4 sets			
		SP2.2.4 Design Drawings - 4 sets			

4.3 Checklist for Structural Design

SUBMISSION DOCUMENT CHECK-LIST			**STRUCTURAL**	**DESIGN**	**SD-SD**
PID				Submitted by	Received By
Project			Name		
Developer			Designation		
Date			Contact No.		
(Note: To be completed by designer / responsible personnel.)			Signature		
Main Subject	Particular			Checked	Remark
SD1 Design Report	SD1.1 Structural System	SD1.1.1 Code of Practice and Design Reference, Specification			
		SD1.1.2 Basic Structural System			
		SD1.1.3 Material Properties			
	SD1.2 Super Structure Design	SD1.2.1 Stability Checks: Base Shear Calculation			
		SD1.2.2 Stability Checks: Drift Limit			
		SD1.2.3 Stability Checks: Mode Participation Ratio			
		SD1.2.4 Stability Checks: Soft Storey			
		SD1.2.5 Stability Checks: P-Δ Effect			
		SD1.2.6 Stability Checks: Overturning			
		SD1.2.7 Stability Checks: Torsional Irregularity			
		SD1.2.8 Stability Checks: Sliding			
		SD1.2.9 Analysis Results			
		SD1.2.10 Structural Design Results			
	SD1.3 Foundation Design	SD1.3.1 Pile Capacity Calculation			
		SD1.3.2 Settlement Calculation			
		SD1.3.3 Foundation Design: Pile, Pile Cap and Mat			
		SD1.3.4 Geotechnical Report and Bore Hole Profile and Location			
		SD1.3.5 Pile Load Test Report			
		SE1.3.6 Liquefaction Analysis Result			

SD2 Design Drawing	SD2.1 Foundation Drawing	SD2.1.1 List of Drawings		
		SD2.1.2 Standard Drawings and General Notes		
		SE2.1.3 Site Location Plan with adjacent building and bore holes		
		SD2.1.4 Foundation Plans		
		SE2.1.5 Structural Detail Drawings [beams, columns, slabs, shear walls and retaining walls (up to another level)		
		SE2.1.6 Basement Floor Plan (if any Basement included)		
		SE2.1.7 Stair Detail (for one level higher)		
		SD2.1.8 Pile, Pile Cap and Mat Details		
	SD2.2 Super Structure Drawing	SD2.2.1 List of Drawings		
		SD2.2.2 Standard Drawings and General Notes		
		SD2.2.3 Structural Plans (beams, columns, slabs)		
		SD2.2.4 Structural Sections		
		SD2.2.5 Structural Member (beams, columns, slab) Details [Typical]		
		SD2.2.6 Stairs Details [Typical]		
		SD2.2.7 Beam Schedules		
		SD2.2.8 Column Schedules		
		SD2.2.9 Shear Wall Details [Typical]		
		SD2.2.10 Shear Wall Schedules		

SD3 Submission Set	SD3.1 Signatures	SD3.1.1 Local Design: Signature of Professional Engineer (Structure) and Professional Engineer (Geotechnical)		
		SD3.1.2 Foreign Design: Signature of Original Structural and Geotechnical Design Engineers		
		SD3.1.3 Foreign Design: Signature of National Counter Part (PE)		
	SD3.2 Document Set	SD3.2.1 CD for Design Drawing , Calculation and Report - 2 sets		
		SD3.2.2 Design Report - 4 sets		
		SD3.2.3 Design Calculation - 4 sets		
		SD3.2.4 Design Drawings - 4 sets		

4.4 Checklist for Deep Excavation Design

SUBMISSION DOCUMENT CHECK-LIST		**STRUCTURAL**	**DEEP EXCAVA- -TION**	**SD-SE**
PID			Submitted by	Received By
Project		Name		
Developer		Designation		
Date		Contact No.		
(Note: To be completed by designer / responsible personnel.)		Signature		
Main Subject	Particular		Checked	Remark
SE1 Design Report	SE1.1 Code of Practice and Design Reference			
	SE1.2 Analysis Methodologies			
	SE1.3 Material Properties			
	SE1.4 Analysis Results			
	SE1.5 Structural Member Checks			
	SE1.6 Geotechnical Report and Bore Hole Profile and Location			
	SE1.7 Drawing List			
	SE1.8 Site Location Plan with adjacent building and bore holes			
	SE1.9 Plans of structure			
	SE1.10 Critical Sections			
	SE1.11 Structural Member Details			
	SE1.12 Joints and Connection Details			
	SE1.13 Construction Sequences			
	SE1.14 Soil Stability Check			
	SE1.15 Monitoring plan and frequency table			

SE2 Submission Set	SE2.1 Signatures	SE2.1.1 Local Design: Signature of Professional Engineer (Geotechnical)		
		SE2.1.2 Foreign Design: Signature of Original Geotechnical Design Engineer		
		SE2.1.3 Foreign Design: Signature of National Counter Part (PE)		
	SE2.2 Document Set	SE2.2.1 CD for Design Drawing , Calculation and Report - 2 sets		
		SE2.2.2 Design Report - 4 sets		
		SE2.2.3 Design Calculation - 4 sets		
		SE2.2.4 Design Drawings - 4 sets		

Note. SE1.6 is not needed to submit if it is included in pile load test.