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The HKIE Structural Examination – Written Examination 2016

Section 2: Design Questions (80% of the Written Examination)

Date: 2 December 2016 (Friday)

Time: 12:00 nn - 06:00 pm

Answer ONE question only

Question 1 The Maritime Museum by the seaside

Client's Requirements

The following client's requirements must be met:

1. A 2-storey glass and steel structure for the Maritime Museum is proposed at the top of a rocky 45-degree slope by the seaside. The top of the slope is 50mPD. The sea level is taken to be 0mPD.
2. The on plan base dimensions of the museum are 100m by 100m. (See Figure Q1 - 1)
3. The storey height of the ground floor is 15m. This is to allow very large exhibits to be accommodated on the ground floor. The storey height of the first floor is 10m. The minimum clear headroom of the ground floor and the first floor are 14m and 9m respectively. (See Figure Q1 - 2)
4. The first floor is to cantilever 15m out towards the sea to give the visitors the breath taking sea view.
5. The enclosure walls should be glass and steel as much as possible to provide natural light.
6. A column free zone is to be provided at 5m from the external walls of the museum. The minimum internal centre-to-centre column spacing on ground floor and first floor is 20m.
7. The top of the foundations should be at least 2m below the ground surface. This is to give enough room for utility services to pass into the site.
8. A minimum 2-hour fire resistance rating is required for all elements of construction for the museum.

Imposed Loads

- | | |
|--------------|-----------------------|
| 9. Roof | 7.5 kN/m ² |
| First floor | 10 kN/m ² |
| Ground floor | 20 kN/m ² |

Wind Loads

10. The wind loads shall be in accordance with the Code of Practice on Wind Effects in Hong Kong 2004.

Site Conditions

11. The site is located at the top of a 45-degree slope above the sea.
12. The top of the slope is 50m above sea level.

Ground Conditions

13. Ground conditions as revealed by the ground investigation boreholes are:-

Ground water is found at 45m below the existing ground level.

From the ground level to a depth of 3m – Very loose and compressible Fill, N values range from 2 to 4.

From 3m to 5m – Strong completely decomposed granite in the form of dense to very dense coarse sands, N values range from 80 to 120.

From 5m onwards – Moderately decomposed (Grade III) granite with total core recovery greater than 85%.

Omit from Consideration

14. Design of glass facade.
15. Design of lift shafts and stair wells.

Section A

- a. Prepare a design study with appropriate sketches and calculations indicating two distinct and viable schemes for the **Maritime Museum structure**. Candidate is allowed to prepare only one viable scheme for the foundations.

(40 marks)

Section B

For the solution recommended in Section A:

- b. Prepare sufficient calculations to establish the size of all the principal structural elements including the foundation.

(20 marks)

- c. Prepare framing plans, sections and elevations to show the dimensions, layout and disposition of the structural elements and critical details for estimating purposes.

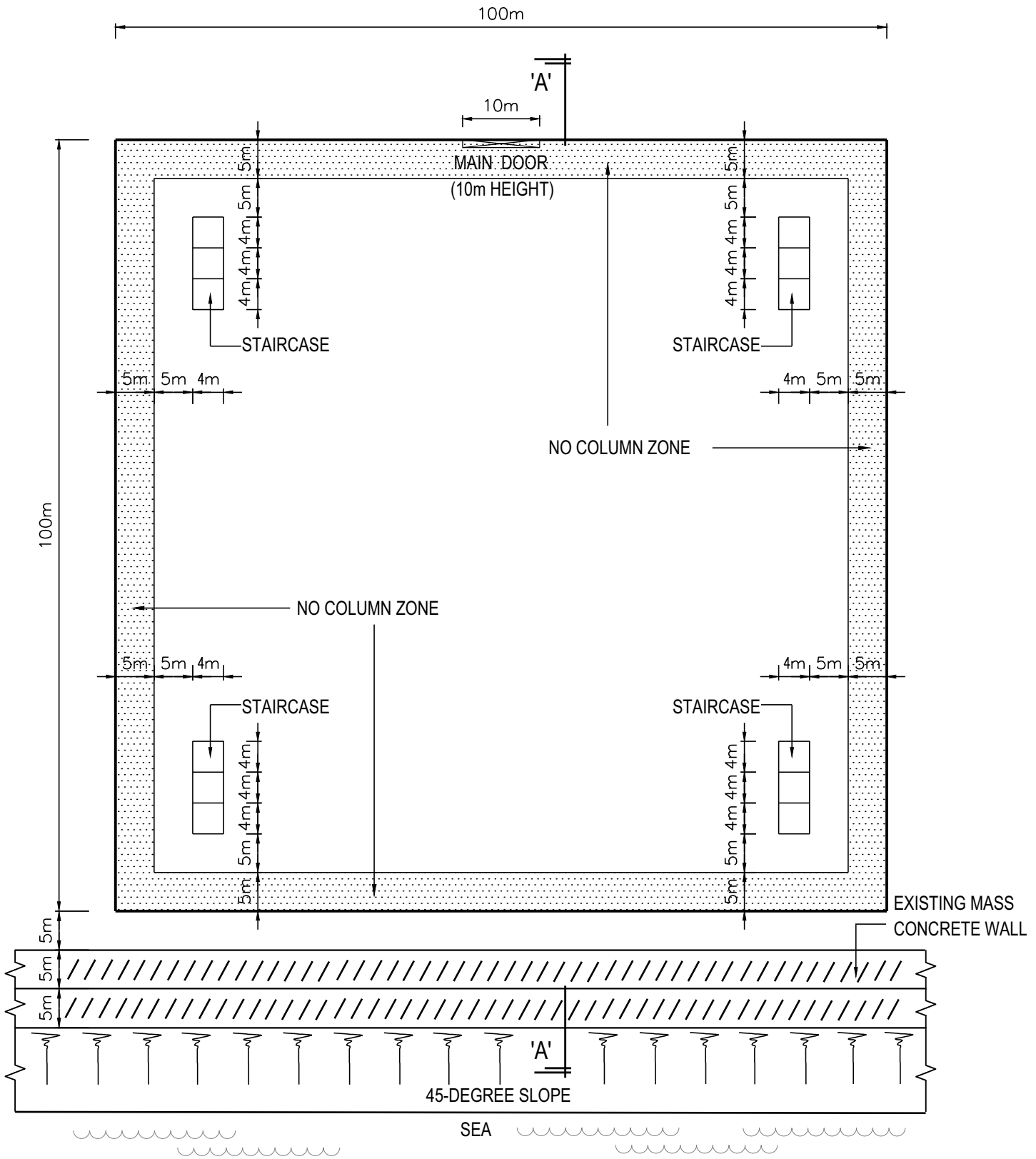
(20 marks)

- d. Prepare a detailed method statement covering essential activities for the safe construction of the structure including foundation works.

(10 marks)

- e. Prepare a detailed construction program covering essential activities from commencement of foundation to completion of structural works.

(10 marks)



GROUND FLOOR PLAN OF MARITIME MUSEUM

(NOT TO SCALE)

Figure Q1 - 1

Question 2 Car Park/Swimming Pool

Client's Requirements

The following client's requirements must be met:

1. A 3-storey split-level car-park with swimming pool at ground level is to be built. See Figure Q2.
2. Car-parking is required on Level 1 to Roof. Entry and exit to the car-park is via an external ramp up to Level 1. Access to other levels of the car-park is via the internal split-level ramps. Staircases and lifts are omitted. The pool depth is 1.5m. Floor to floor heights are shown in Figure Q2. Minimum clear headroom of the car park levels and the swimming pool level is 2.4m and 5.0m respectively. There is no restriction on the roof height.
3. Each parking bay is to be a minimum of 2.5m wide and 5.0m long. 7.0m wide traffic lanes are required on each parking level as shown in Figure Q2. No structure is permitted in the traffic lane. No internal column/load bearing wall is permitted in the swimming pool area.
4. A fire resistance of 2 hours is required for all structural elements.

Imposed Loads

5. Car park floors, roof and ramps 3.0 kPa
Ground level and Plant room 7.5 kPa

Wind Loads

6. The wind loads shall be in accordance with the Code of Practice on Wind Effects in Hong Kong 2004.

Site Conditions

7. The site is level and is located in Tsim Sha Tsui.

8. Ground conditions:

Ground level – 3.0m	Loose fill
3.0m – 10.0m	Sand/gravel, SPT N-value = 25
Below 10.0m	Bed rock

Ground water is found at 3.0m below the existing ground level.

Omit from Consideration

9. Detail design of the external ramp.

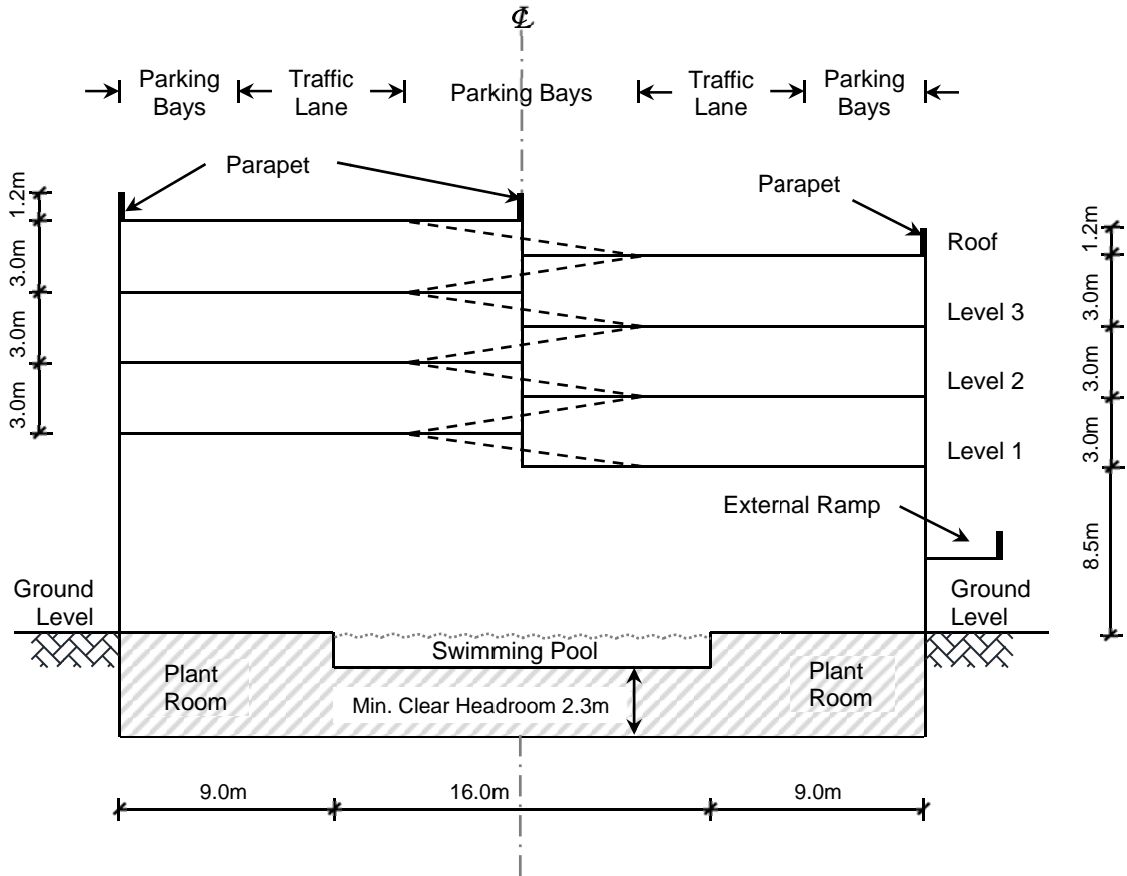
Section A

- a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable solutions for the proposed structure including the foundation. Indicate clearly the functional framing, load transfer and stability aspects of each scheme. Identify the solution you recommend and give the reasons for your choice.
- (40 marks)**

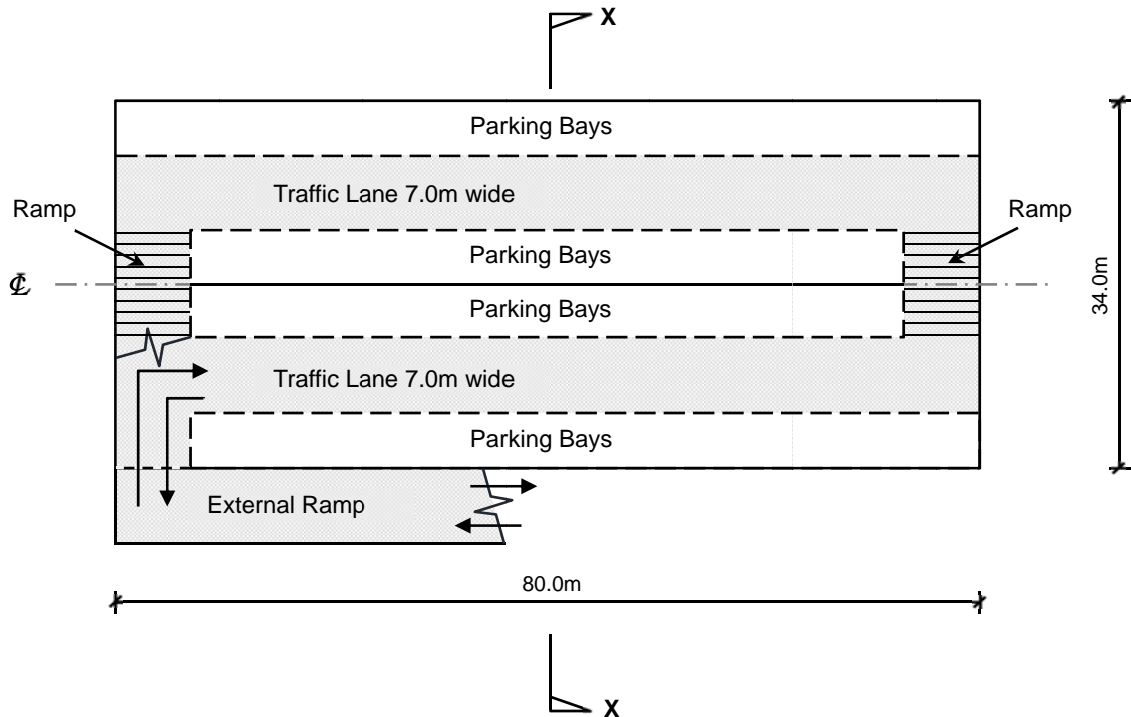
Section B

For the solution recommended in Section A:

- b. Prepare sufficient design calculations to establish the size of all the principal structural elements including the foundation.
- (20 marks)**
- c. Prepare framing plans, sections and elevations to show the dimensions, layout and disposition of the structural elements and critical details for estimating purposes.
- (20 marks)**
- d. Prepare a detailed method statement covering essential activities for the safe construction of the structure including foundation works.
- (10 marks)**
- e. Prepare a detailed construction program covering essential activities from commencement of foundation to completion of structural works.
- (10 marks)**

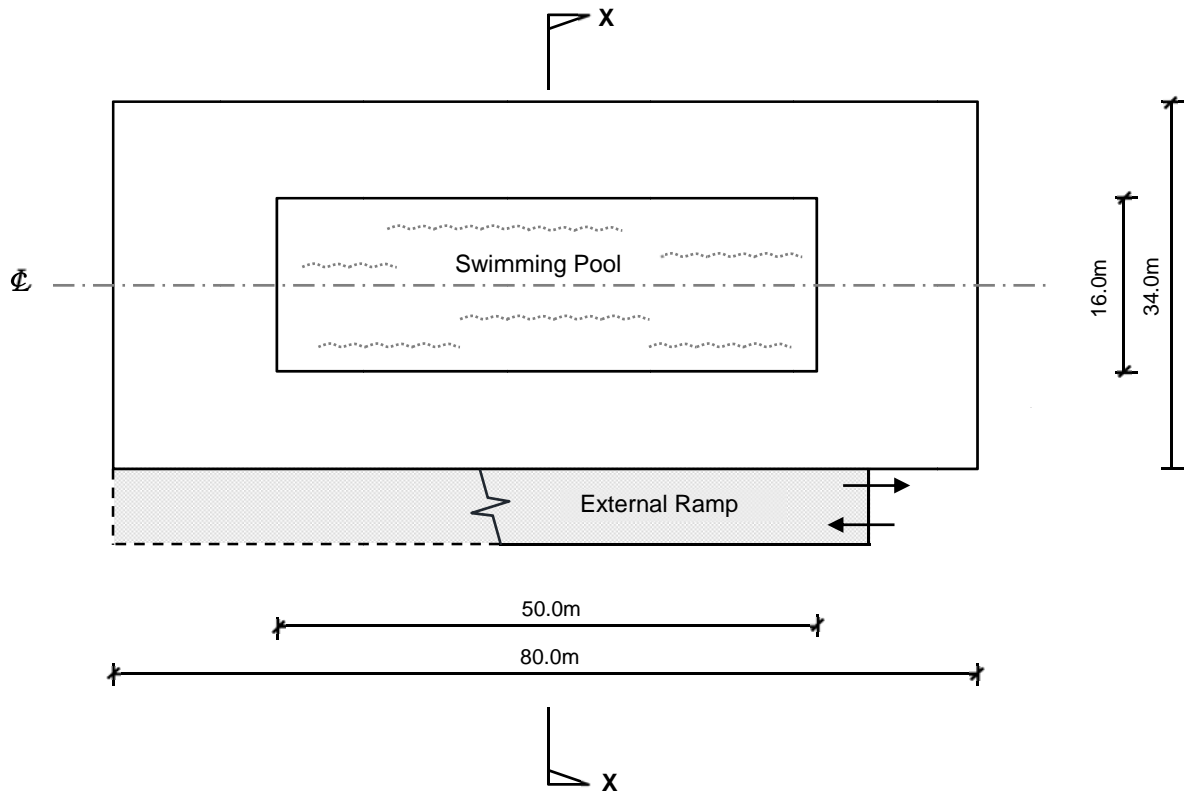


SECTION X-X



FLOOR PLAN OF CAR PARK AT LEVEL 1

Figure Q2



FLOOR PLAN AT GROUND LEVEL

Figure Q2

Question 3 Commercial Building

Client's Requirements

The following client's requirements must be met:

1. A commercial building is to be constructed within the urban area of Hong Kong Island. See Figure Q3.
2. The proposed use of commercial building with the minimum headroom requirements and fire resistance rating is listed as follows:

Floor Mark	Usage	Minimum Clear Headroom* (m)	Maximum depth of structures along periphery of the building (m)	Fire Resistance Rating
26/F – 45/F	Hotel guest room	2.5	0.5	1 hour
25/F	Refuge floor	2.3	1.7	
3/F – 24/F	Office	3.3	0.7	
2/F	Shop	3.8	0.7	2 hours
1/F	Shop	3.8	0.7	
G/F	Lobby and shop	3.8	0.7	

* The minimum clear headroom is the floor height clear of all structures and building services. A service zone of minimum 500mm depth should be allowed for underneath all floors.

3. The restrictions on the location of vertical structural elements are as follows:

Floor Mark	Area	Restrictions
26/F – 45/F	Hotel guest room	- No internal columns permitted inside the guest rooms and corridor.
25/F	Refuge floor	- No internal columns permitted.
3/F – 24/F	Office	- Minimum spacing of columns is 7.5m centres.
G/F – 2/F	Lobby and shop	- Minimum spacing of columns is 7.5m centres.

4. The main roof structure above tower and flat roof structure above shops at 2/F shall not be inverted.

Imposed Loads

5. The imposed loads shall be in accordance with the Hong Kong Code of Practice for Dead and Imposed Loads 2011.

Wind Loads

6. The wind loads shall be in accordance with the Code of Practice on Wind Effects in Hong Kong 2004.

Site Conditions

7. Ground Conditions:

From +5mPD to -5mPD : Loose Fill with SPT N-value < 10

From -5mPD to -25mPD : Medium dense sand with SPT N-value 10-50

Below -25mPD : Slightly to moderately decomposed moderately strong rock of material weathering grade III or better, with total core recovery of more than 85% of the grade.

Omit from Consideration

8. Detailed layout and design of the structure inside the service core.

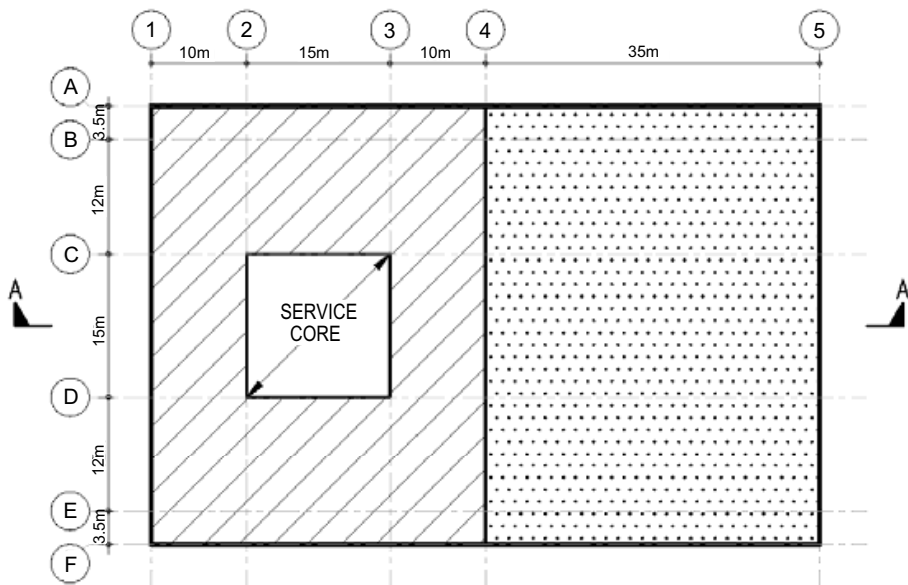
Section A

- a. Propose one feasible structure scheme for each of the hotel and office portions. Based on the proposed schemes, provide two distinct and viable solutions with the aid of appropriate sketches for the transfer structure at the refuge floor. Indicate clearly the functional framing and load transfer path for each scheme. Identify the solution you recommend and give the reasons for your choice.
- (40 marks)**

Section B

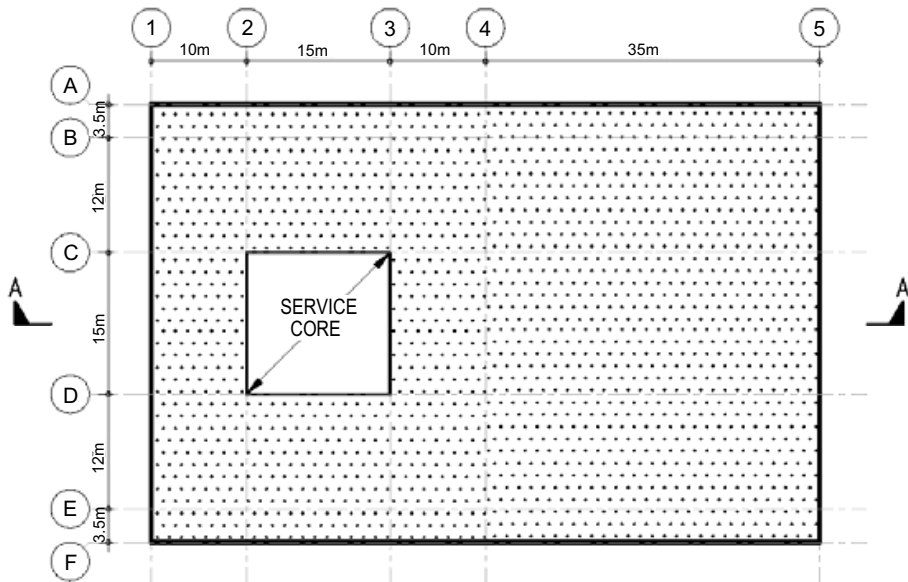
For the solution recommended in Section A:

- b. Prepare design calculations to establish the form and size of all the principal structural elements for the superstructure from 24/F to 27/F, including transfer structure.
- (14 marks)**
- c. Prepare dimensioned framing plans for 24/F to 27/F, including transfer structure.
- (20 marks)**
- d. Prepare structural details for the principal structural elements from 24/F to 27/F, including transfer structure, for cost estimation purposes.
- (14 marks)**
- e. Prepare the design calculations for the building foundation.
- (4 marks)**
- f. Prepare a preliminary foundation layout plan.
- (4 marks)**
- g. Prepare an outline construction programme covering essential activities from commencement of foundation to completion of building.
- (4 marks)**



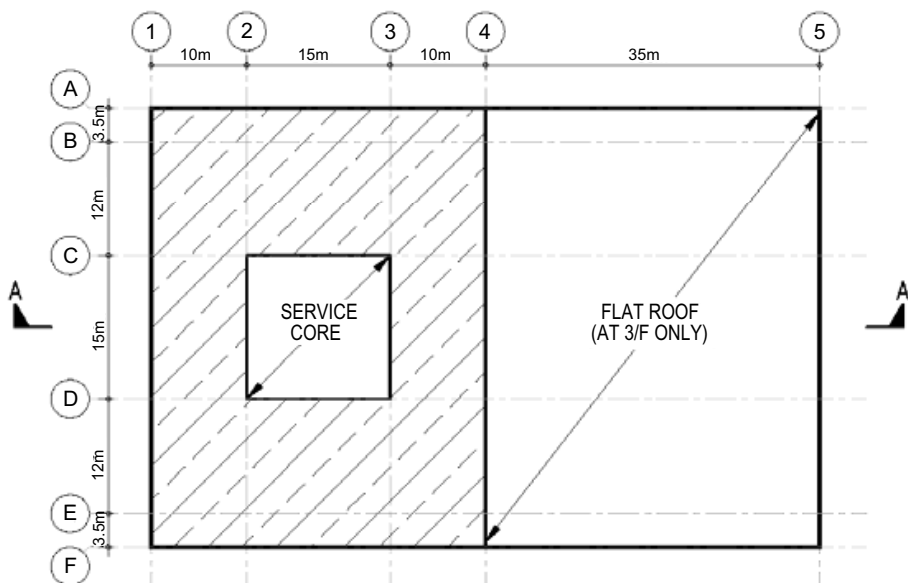
G/F FLOOR PLAN

▨ LOBBY ▩ SHOP



1/F & 2/F FLOOR PLAN

▩ SHOP



3/F TO 25/F FLOOR PLAN

▨ OFFICE / REFUGE FLOOR AREA

Figure Q3

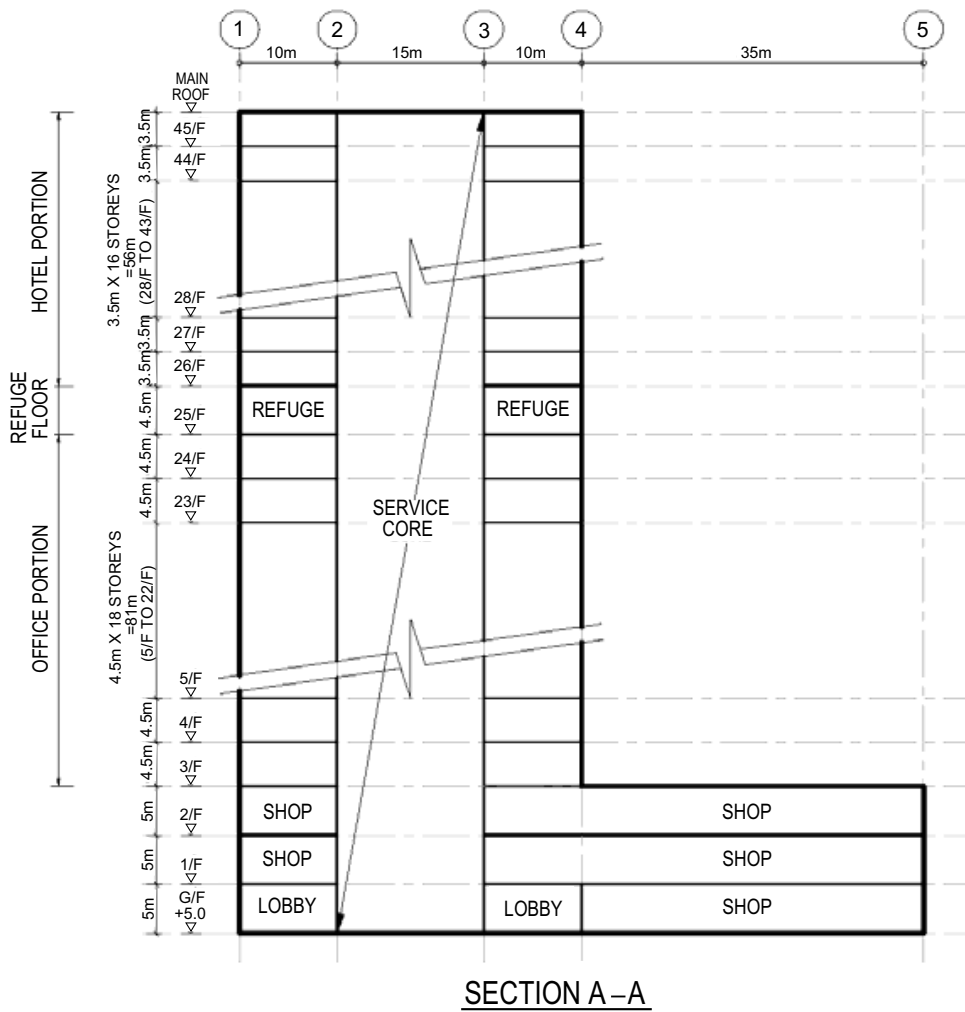
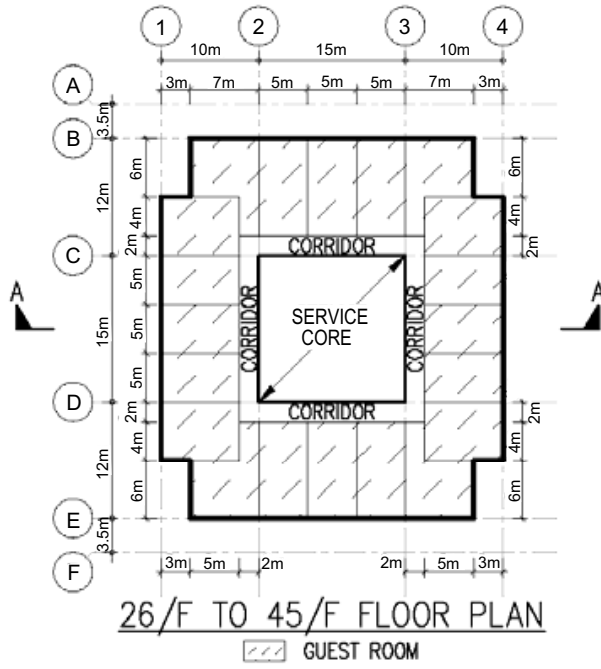


Figure Q3

Question 4 Institution Building

Client's Requirements

The following client's requirements must be met:

1. A seven storey institution building is to be constructed in the university campus in Hong Kong. See Figure Q4.
2. No internal column is permitted inside the classrooms.
3. Minimum 3m width corridor at typical floors is to be provided.
4. No internal column is permitted inside the multi-purpose function room.
5. Minimum column spacing at office area on ground floor is 10m.
6. 250mm curtain wall is to be allowed at the perimeter of the building to allow for natural lighting.
7. Minimum requirements on clear headroom (clear height of all structure, finishes and building services) are as follows:

<u>Floor</u>	<u>Usage</u>	<u>Min. Clear Headroom (m)</u>	<u>Finishes & E/M Zone (m)</u>
G/F	Multi-purpose function room	6.0	0.5
G/F	Office / Entrance lobby	4.0	0.4
1/F	Office	4.0	0.4
2/F – 6/F	Classrooms	4.0	0.4

8. A minimum 2-hour fire resistance rating is required.

Imposed Loads

9. The imposed loads shall be in accordance with the Hong Kong Code of Practice for Dead and Imposed Loads 2011.

Wind Loads

10. The wind loads shall be in accordance with the Code of Practice on Wind Effects in Hong Kong 2004.

Site Conditions

11. The site is located at a datum level of about +6.0mPD.

12. Ground conditions are:

Ground level – 15m	Alluvium, SPT N-value = 10
15m – 35m	CDG, SPT N-value = 200
35m – 45m	HDG, SPT N-value greater than 300
45m and below	Moderately decomposed weak rock of material weathering grade better than IV, with total core recovery of more than 50% of the grade

Ground water is encountered at 4.0m below ground level.

Section A

- a. Prepare a design appraisal with appropriate sketches including two distinct and viable solutions for the proposed institution building including two viable foundation schemes. Indicate clearly the functional framing, load transfer and stability aspects of each scheme to meet all client's requirements. Identify the solution you recommend and give reasons for your choice.

(30 marks)

- b. Explain how the building structure will resist wind load including detailed description of the structural wind loads and design assumption. Prepare a detailed wind load calculation for the proposed institution building.

(10 marks)

Section B

For the solution recommended in Section A:

- c. Prepare sufficient design calculations to establish the form and size of all the principal structural elements including the foundation.

(20 marks)

- d. Prepare general detailed structural framing plans to show the dimensions, arrangement of the structural elements and details of all critical structural elements for estimating purposes.

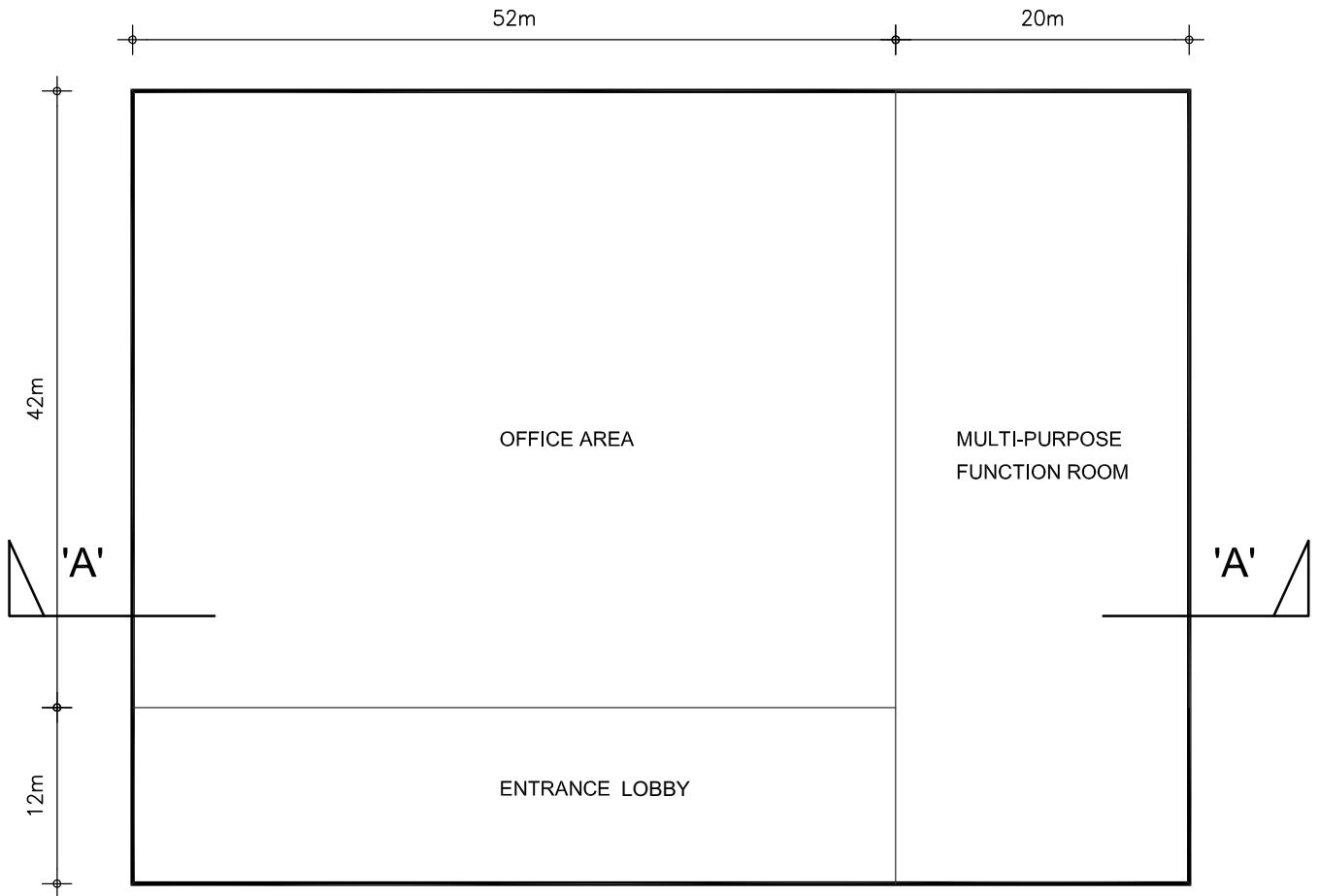
(20 marks)

- e. Prepare a detailed method statement covering essential activities for the safe construction of the building including foundation works.

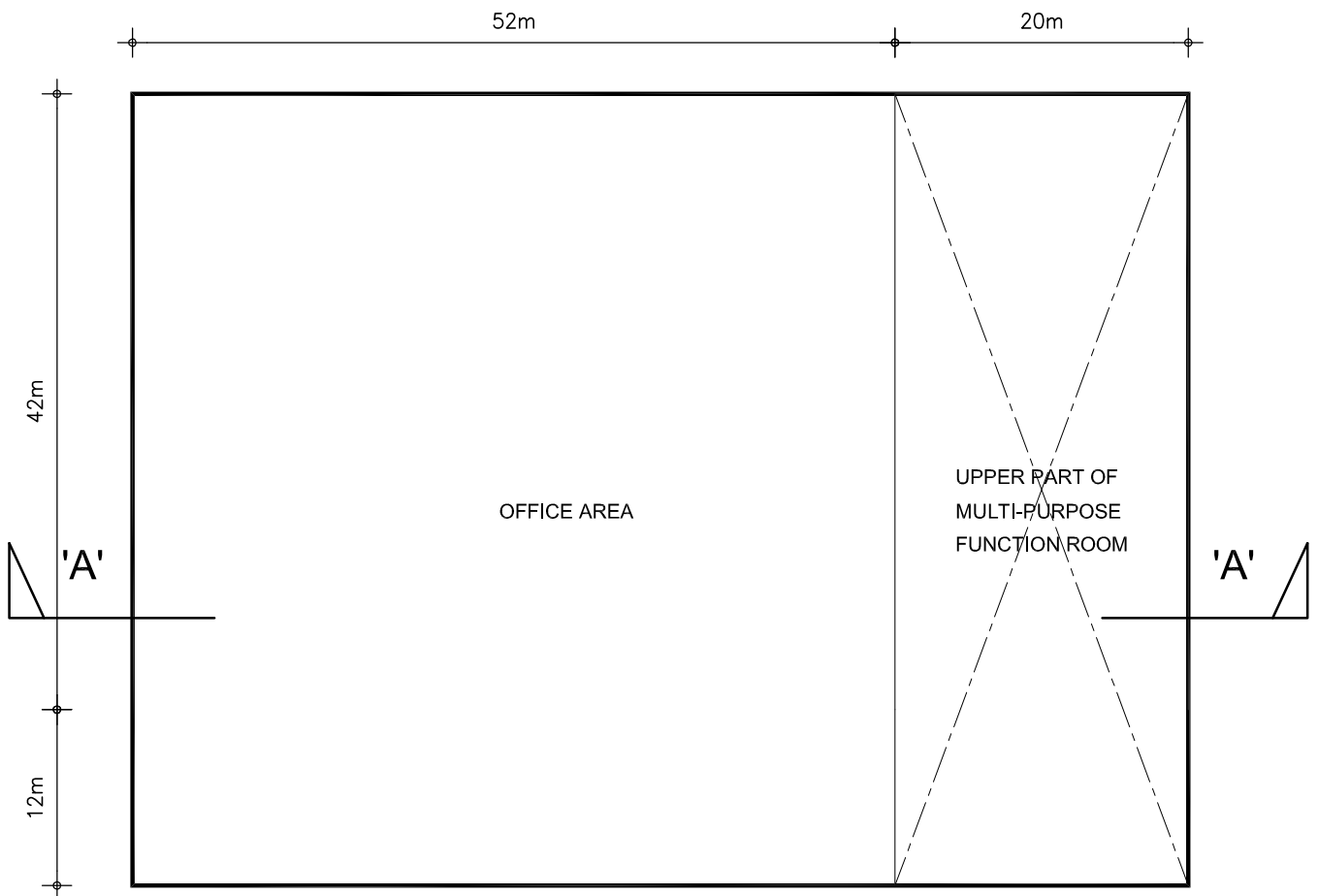
(10 marks)

- f. Prepare a detailed construction program covering essential activities from commencement of foundation to completion of structural works.

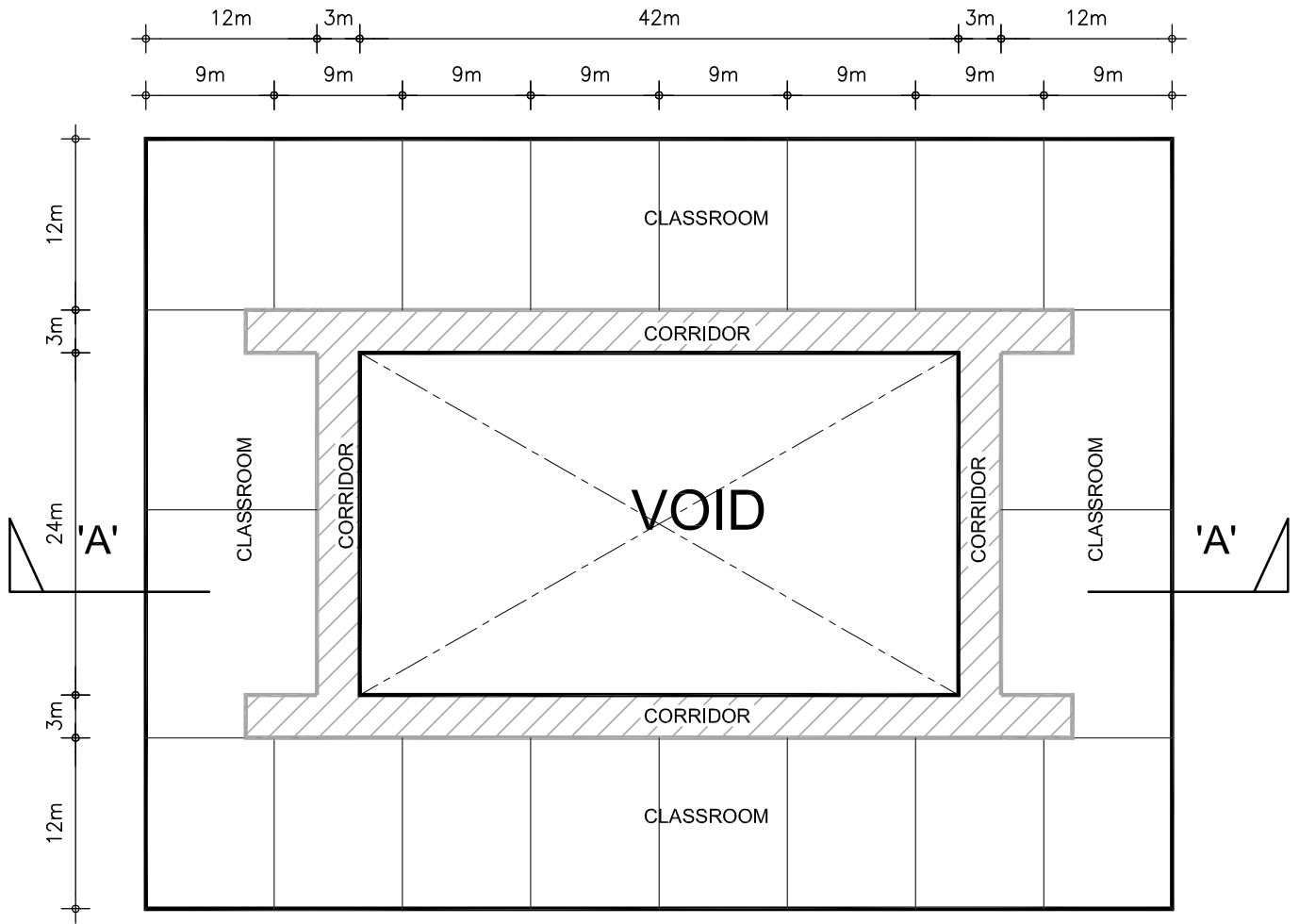
(10 marks)



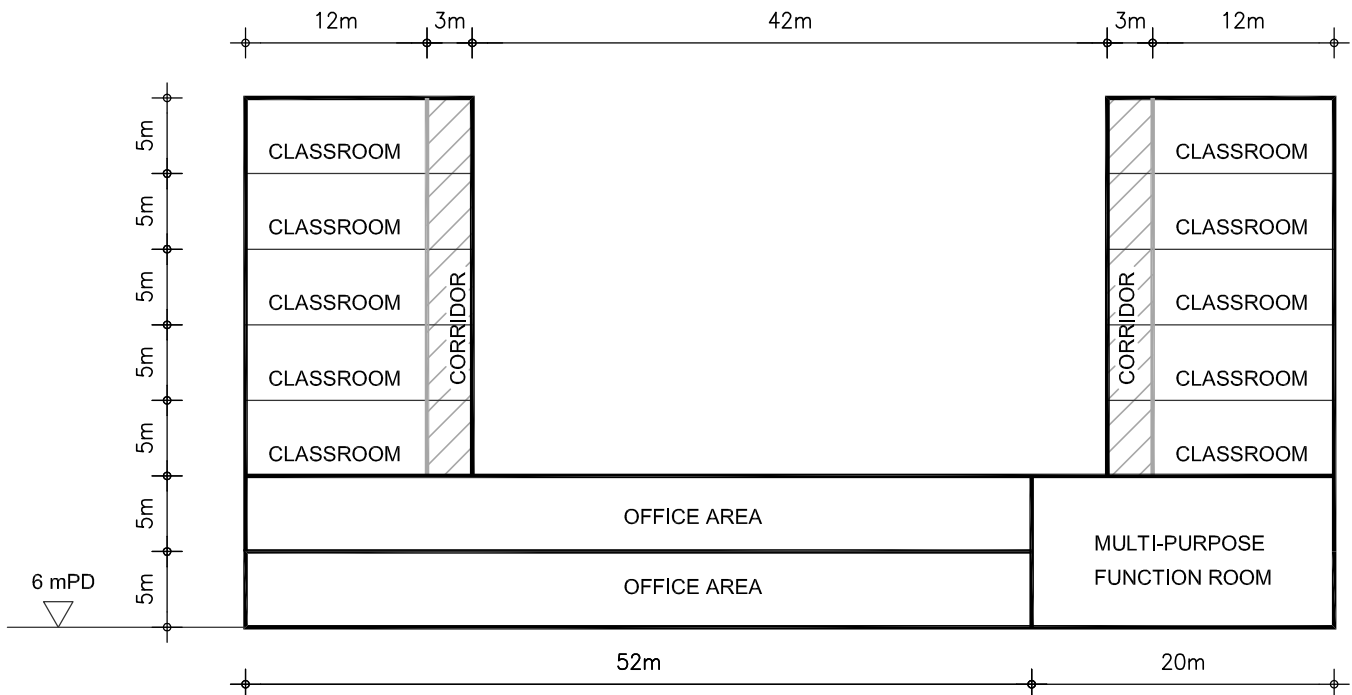
G/F FLOOR PLAN



1/F FLOOR PLAN



2/F TO 6/F FLOOR PLAN



SECTION 'A'-'A'

Figure Q4

Question 5 Footbridge with Green Roof

Client's Requirements

The following client's requirements must be met:

1. A new open footbridge with green roof is proposed to connect two existing buildings as shown in Figure Q5.
2. Two concrete corbels as shown in Figure Q5, one at each existing building, will be built for supporting the new footbridge. Each corbel will be designed with sufficient strength to take any magnitude of vertical and horizontal loads from the new footbridge.
3. Three staircases, two at the north and one at the south of the new footbridge will be built in the next contract. Therefore sufficient wide openings must be provided in the new footbridge for the future staircases. For safety sake, temporary fencings will be provided by the client to close the gaps for the time being.
4. Any column support to the new footbridge must maintain a horizontal clearance of 1.0m between the highway envelope and the face of the column support.
5. No permanent nor temporary work may be placed within the carriageway at all time.

Design Requirements

6. The structural design shall be in accordance with the Structures Design Manual for Highways and Railways 2013.

Imposed Loads

- | | | |
|--------------------|-----|------------------------|
| 7. Footbridge load | LL | 5 kN/m ² |
| Green Roof | LL | 0.75 kN/m ² |
| | SDL | 5 kN/m ² |

Site Conditions

8. The site is in the rural area.
9. Ground conditions as revealed by boreholes are:

Ground level – 0.8m Made up ground

0.8m -12.0m Soft clay with undrained shear strength, $C_u = 40.0 \text{ kN/ m}^2$

Below 12.0m Moderately decomposed rock with allowable bearing
Pressure = $3,000 \text{ kN/ m}^2$

Ground water was encountered at 2.8m below ground level.

Omit from Consideration

10. Design calculations for the staircases and concrete corbels are not required.

Section A

- a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable schemes for the proposed footbridge including the foundations and the green roof. The functional framing, load transfer, safety and stability aspects of your schemes must be clearly indicated. Identify the solution you recommend and give the reasons for your choice.

(40 marks)

Section B

For the solution recommended in Section A:

- b. Prepare sufficient design calculations to establish the form and size of all main components including foundations.

(20 marks)

- c. Prepare general arrangement drawings including sufficient plans, elevations, sections etc. for the footbridge structure including the green roof for quantity taking off purposes.

(20 marks)

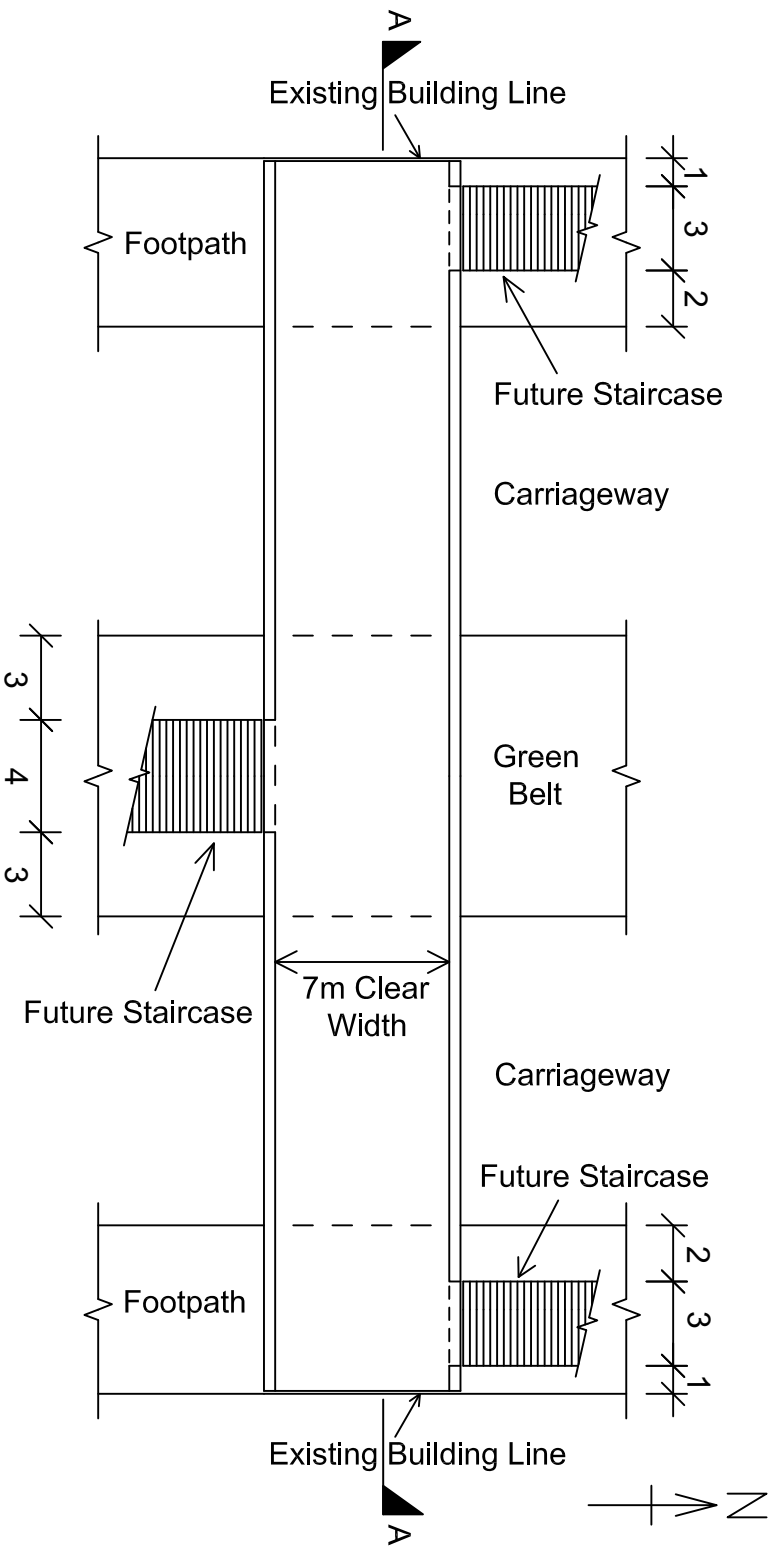
- d. Prepare a detailed method statement covering essential activities for the safe construction of the footbridge including foundation works.

(10 marks)

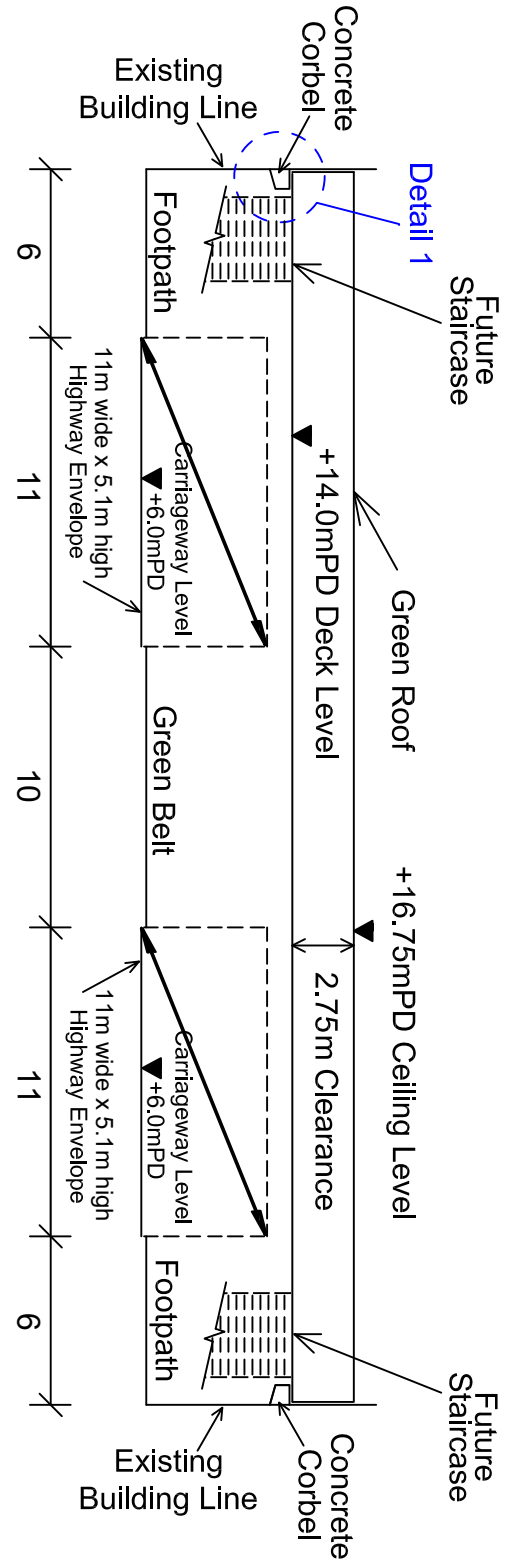
- e. Prepare a detailed construction program covering essential activities from commencement of foundation to completion of structural works.

(10 marks)

PLAN OF OPEN FOOTBRIDGE



SECTION A-A



Note
All Dimensions
Are In Meters

End of Paper

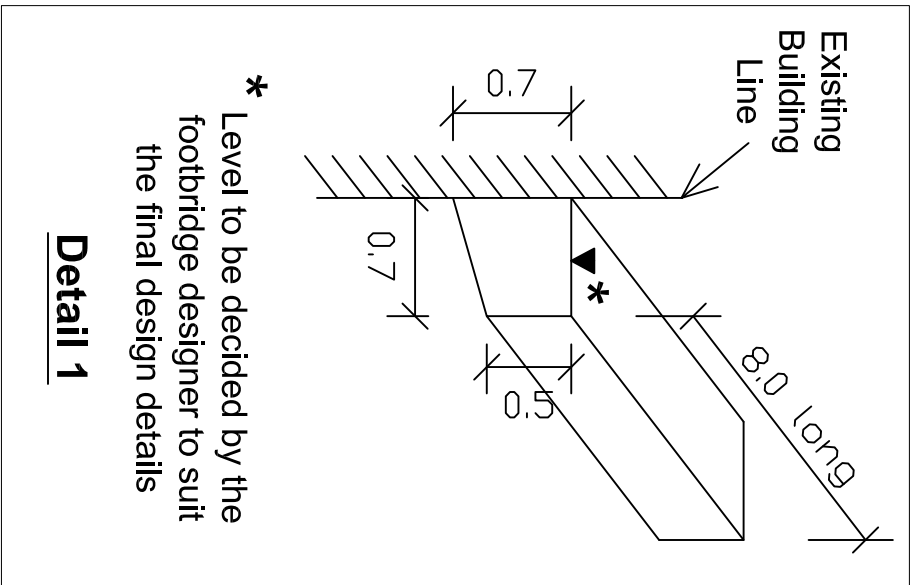


Figure Q5