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The HKIE Structural Examination – Written Examination 2018

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

Date: 7 December 2018 (Friday)
Time: 12:15 pm – 6:15 pm
(Duration: 6 hours)

Question Paper

Answer ONE question only

Question 1 An Aircraft Hangar by the Seaside

Client's Requirements

The following client's requirements must be met:

1. A large span structure for a new aircraft hangar is proposed near the seaside. The ground level is +5 mPD. The sea level is taken to be 0 mPD. See figure Q1.
2. The on plan dimensions of the hangar are 150m by 150m. (Figure Q1 - 1)
3. The clear headroom of the hangar is 25m. A two-storey office (plan area 100m by 20m) is located at the back of the hangar. The storey height and clear headroom of each of the office floors is 5m and 3.5m respectively. (Figure Q1 - 2)
4. The enclosure walls should be steel cladding panels with at least 15% of the wall areas to be glass windows.
5. An 130m by 130m wide structure-free zone is to be provided at the entrance and inside the hangar to allow the movement of aircrafts.
6. 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.
7. A minimum 2-hour fire resistance rating is required for all elements of construction for the hangar.

Imposed Loads

8.	Roof of hangar	10kN/m ²
	Ground floor of hangar	20kN/m ²
	Office:-	
	First floor	10kN/m ²
	Ground floor	20kN/m ²

Wind Loads

9. The site is located near the sea. The structure shall be checked against wind loads in accordance with the Code of Practice on Wind Effects in Hong Kong 2004.

Site Conditions

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

From Ground level to 3m Very loose and compressible fill, SPT 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, SPT N-values range from 80 to 120.

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

Groundwater table is found at 3.5m below the existing ground level.

Omit from Consideration

11. Design of wall and roof panels.
12. Design of lift shafts and stair wells for the office.
13. Design of the sliding door at the entrance of the hangar.

Section A

- a. Prepare a design appraisal with appropriate sketches and calculations indicating two distinct and viable solutions for the proposed aircraft hangar and office structures. Candidate is allowed to prepare only one viable scheme for the foundations. 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.

(40 marks)

Section B

For the solution recommended in Section A:

- b. Prepare sufficient design calculations to establish the form and 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.

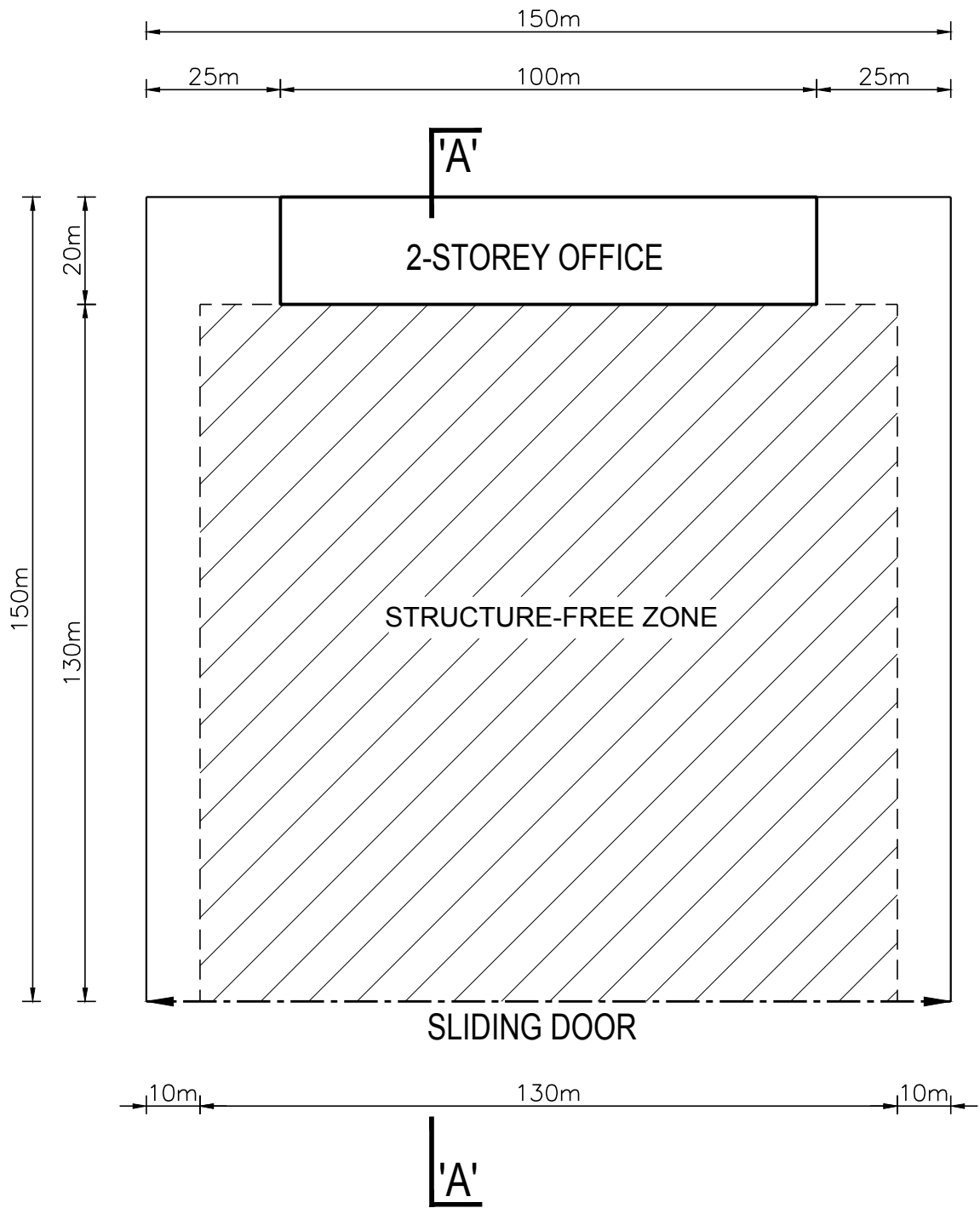
(20 marks)

- 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)



PLAN OF THE AIRCRAFT HANGAR

Figure 1.1

Figure Q1

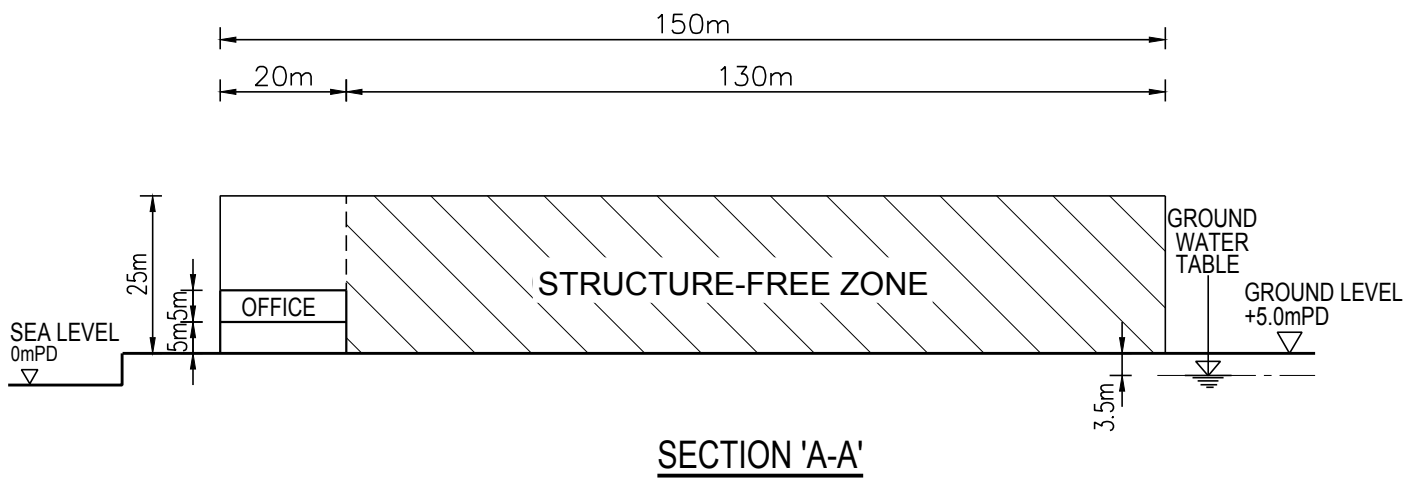


Figure UFA2

Figure Q1

Question 2 Research Centre

Client's Requirements

The following client's requirements must be met:

1. A research centre building is to be constructed within the New Territories area of Hong Kong. See figure Q2.
2. The proposed use of research centre building with the minimum headroom requirements and fire resistance rating is listed as follows:

Floor Mark	Usage	Min. Clear Headroom* (m)	Fire Resistance Rating	Finishes & E/M Services Zone (m)
1/F to 4/F	Laboratory	3.5	2 hours	0.5
1/F	Exhibition Hall	7.0	2 hours	0.5
G/F to M/F	Office	2.5	2 hours	0.5
G/F	High ceiling Laboratory	6.0	2 hours	0.5
G/F	Entrance Lobby	5.0	2 hours	0.5
B/F	Car Park	2.5	4 hours	0.5

* The minimum clear headroom is the floor height clear of all structures, finishes and building services.

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

Floor Mark	Area	Restrictions
G/F – 4/F	Entrance Lobby, Office and All Laboratories	- Minimum spacing of internal columns is 9.0m centres. - No restriction on spacing between the internal column to peripheral wall and/or column if any.
1/F	Exhibition Hall	- Column free area.
G/F	Driveway/Ramp	- No column/wall permitted inside the driveway and access ramp.
B/F	Car Parking	- Minimum spacing of internal columns is 9.0m centres.

Imposed Loads

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

Wind Loads

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

Site Conditions

6. Abutting the eastern boundary of the site is a 30° natural slope.
7. Ground conditions are:

Borehole No.1

From +14mPD to +8mPD : Loose fill with SPT N-value < 10.

Below +8mPD : 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.

Borehole No.2

From +10mPD to -0mPD : Loose Fill with SPT N-value < 10.

From -0mPD to -4mPD : Medium dense sand with SPT N-value 10 – 50.

Below -4mPD : 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.

The groundwater level is at one meter below existing ground level.

Omit from Consideration

8. Detailed layout and design of the structure inside the service core.
9. Detailed layout and design of the car park ramp.
10. Design of curtain wall.

Section A

- a. Prepare an overall design appraisal of the proposed structure. Prepare ONE viable structural scheme for the research centre building. Based on the proposed structural scheme for the research centre building, provide TWO distinct and viable solutions with the aid of appropriate sketches for the proposed superstructure for the exhibition hall between grid A to C and from 1/F to 4/F. 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 principal structural elements for superstructure from G/F to 3/F, including transfer and/or cantilever structures.

(14 marks)

- c. Prepare dimensional framing plans for G/F to 3/F including transfer and/or cantilever structures.

(20 marks)

- d. Prepare structural details for the principal structural elements from G/F to 3/F, including transfer and/or cantilever structures, for cost estimation purpose.

(14 marks)

- e. Prepare the design calculation for the building foundation.

(4 marks)

- f. Prepare a preliminary foundation layout plan.

(4 marks)

- g. Prepare an outline construction program covering essential activities from commencement of foundation to completion of structural works.

(4 marks)

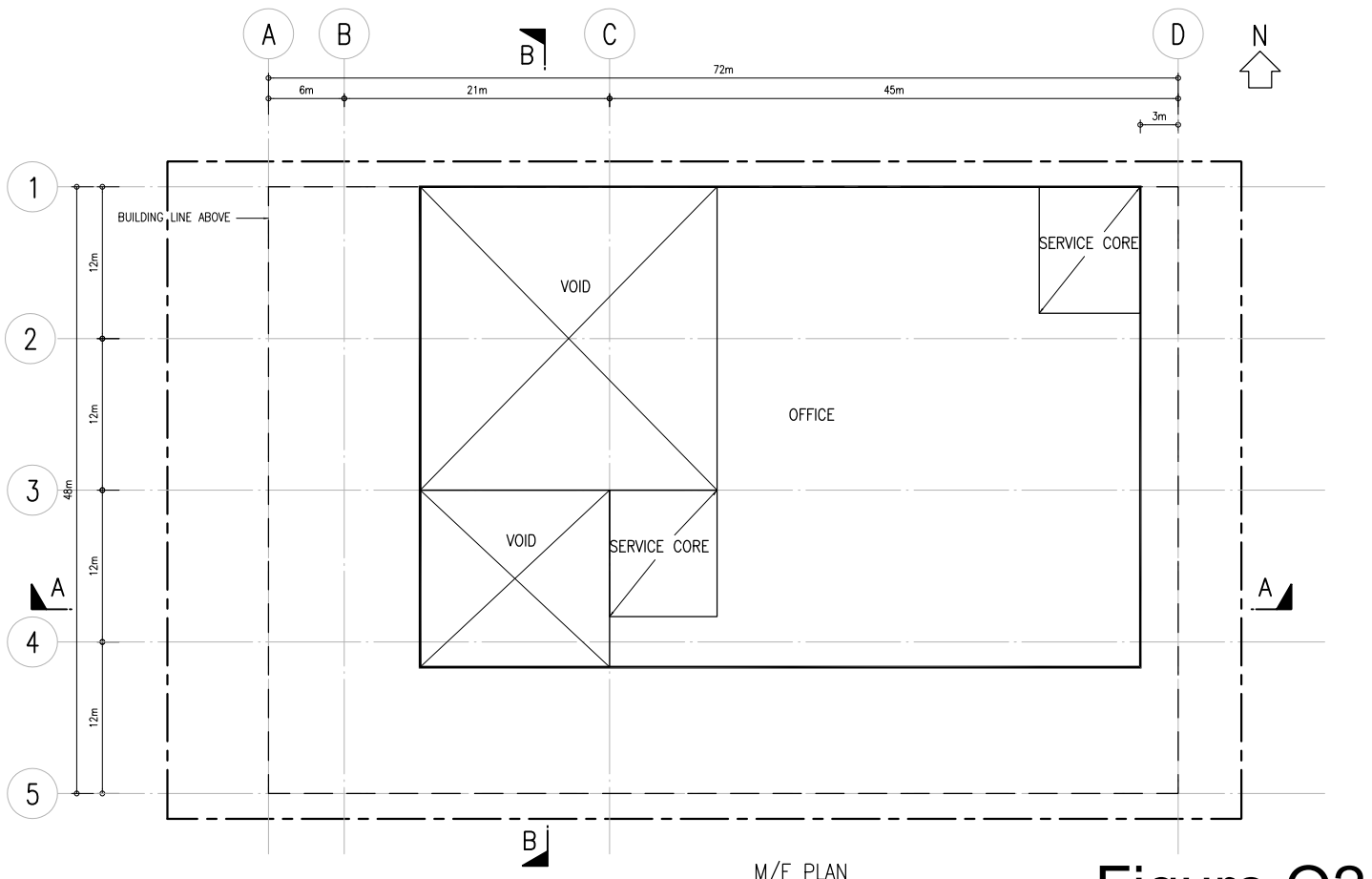
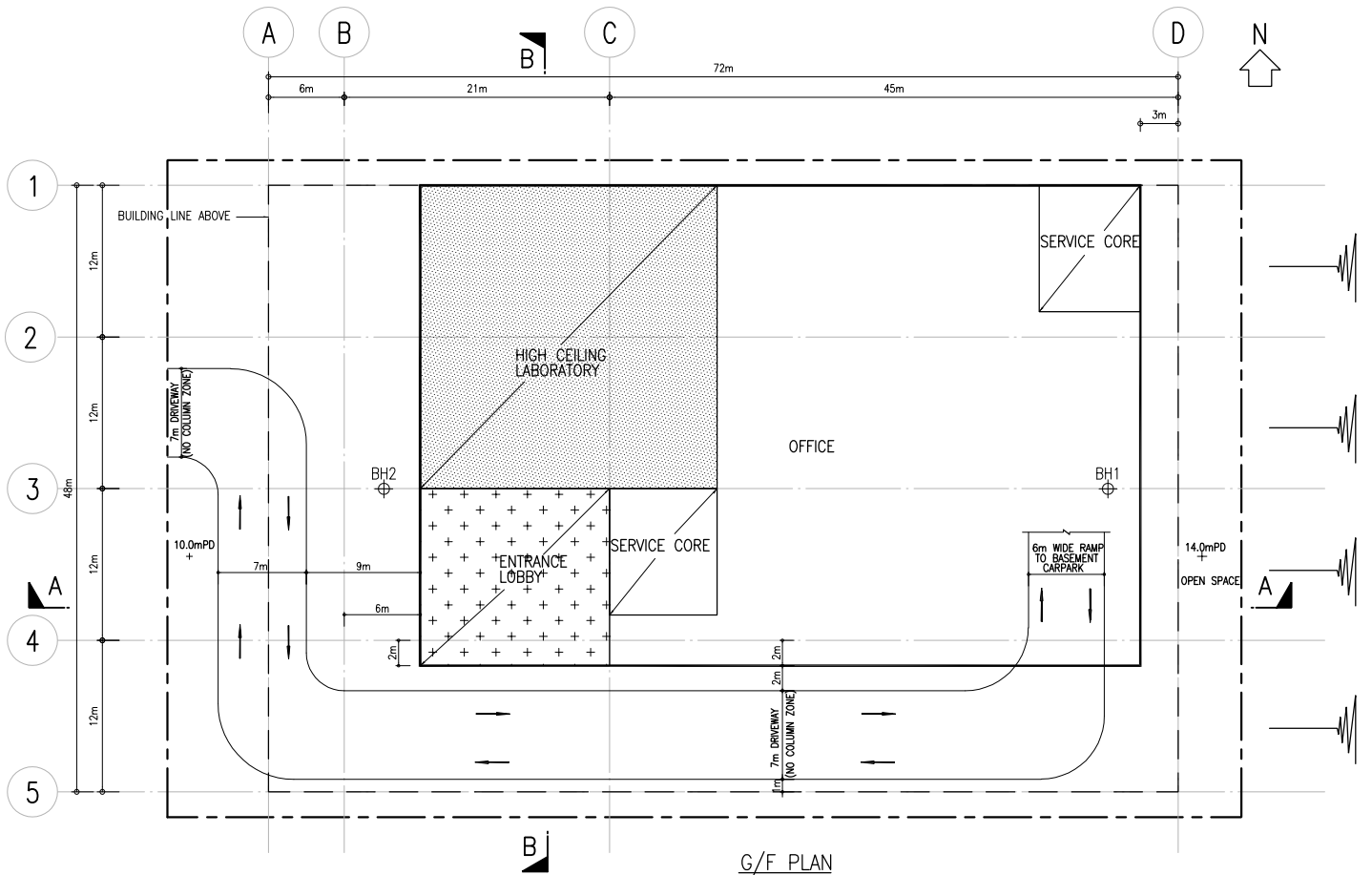


Figure Q2

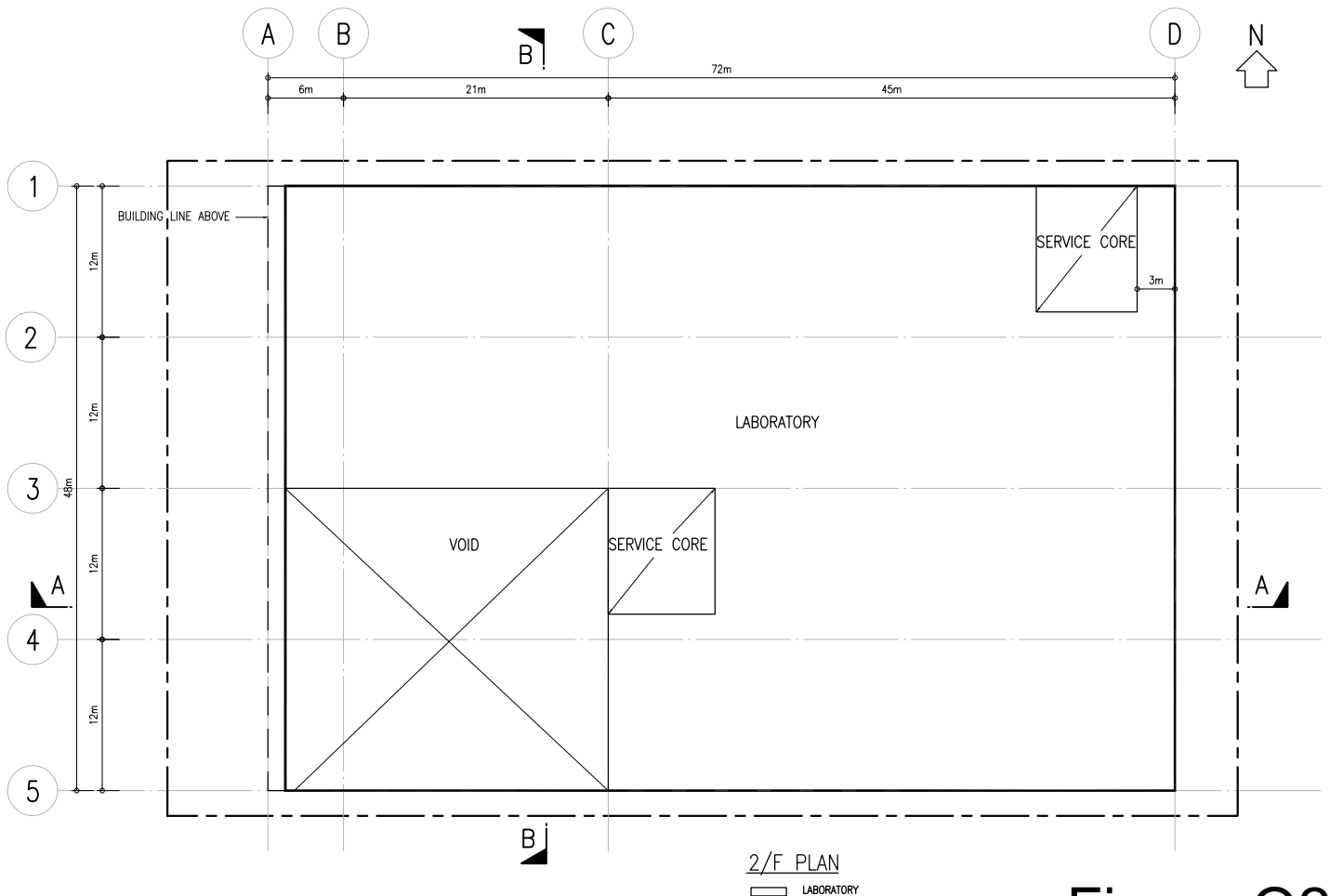
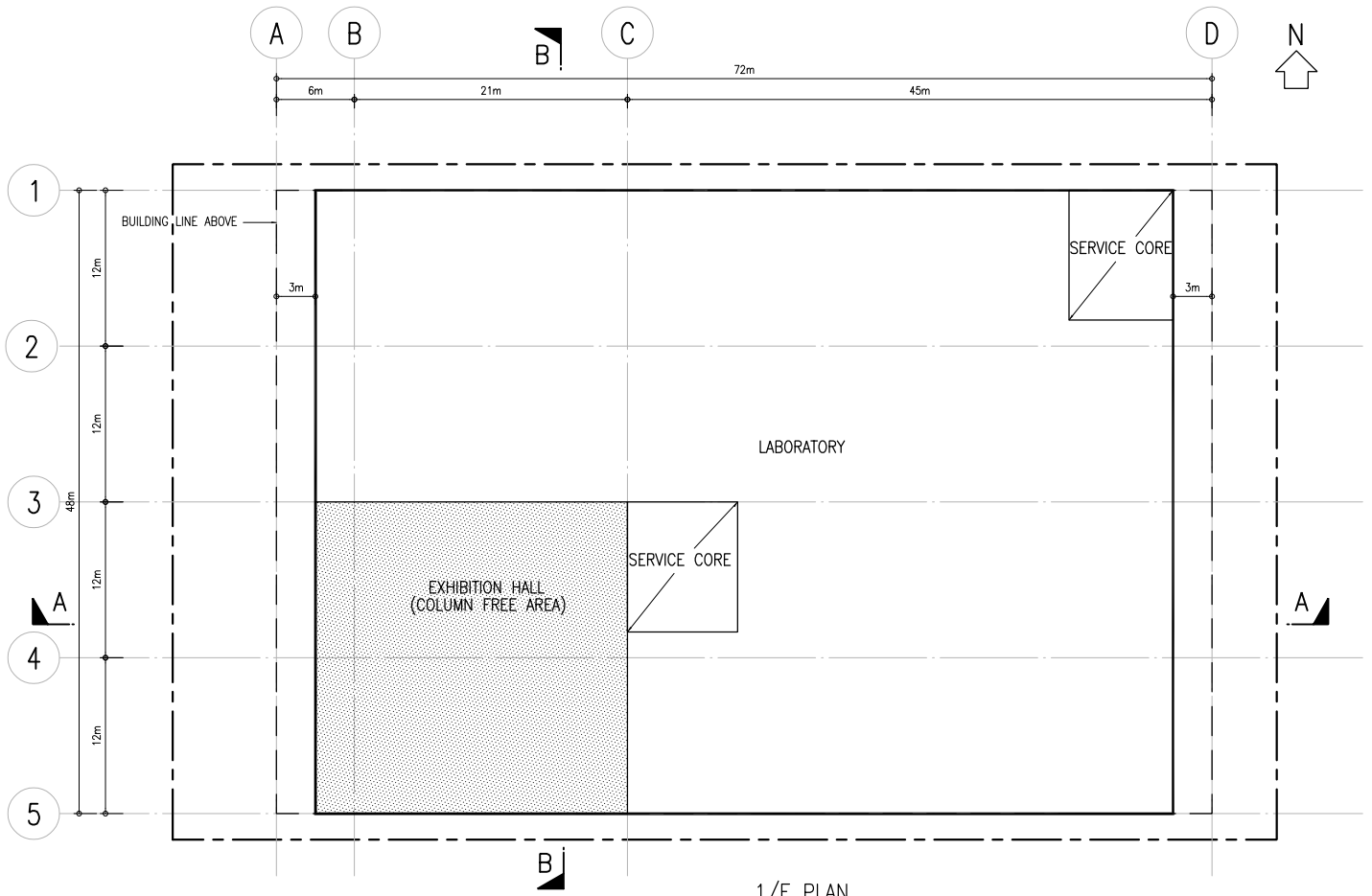


Figure Q2

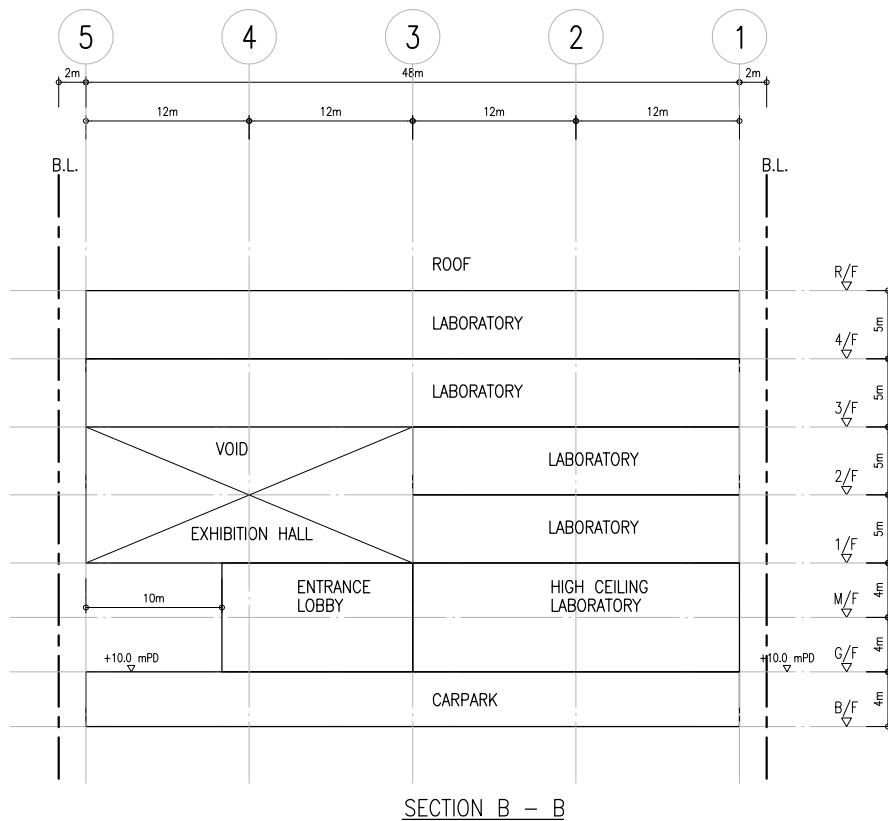
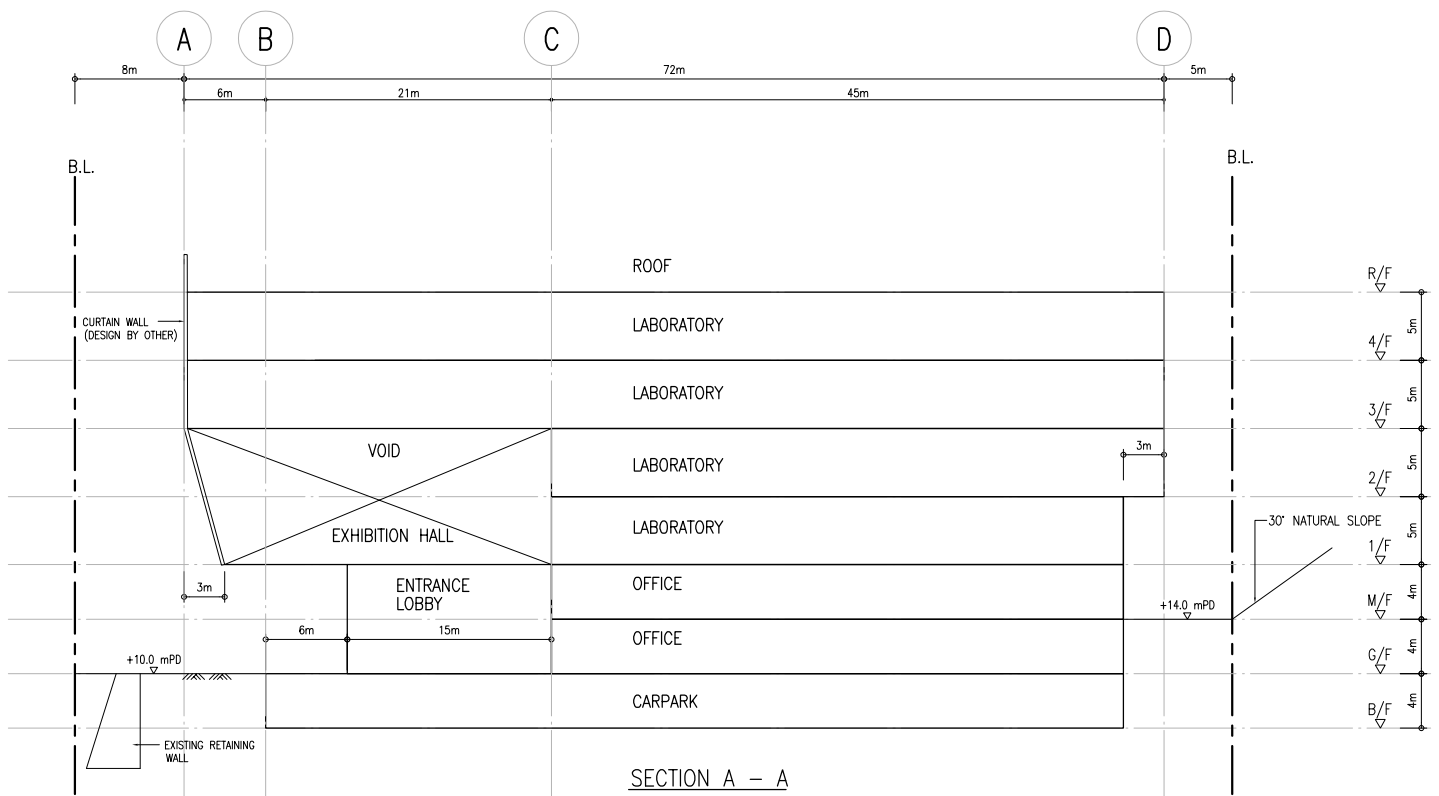


Figure Q2

Question 3 Extension of Logistic Centre

Client's Requirements

The following client's requirements must be met:

1. A two-storey building is proposed adjacent to an existing logistic centre as an extension. The client requests the construction of extension to be fast-track. In order not to affect the operation of logistic centre, the client also expressed vibration induced by any construction activities to the existing building should not exceed peak particle velocity of 5mm/s. See figure Q3.
2. The existing logistic centre building is a four-storey reinforced-concrete structure enclosed by curtain wall façade supported on deep foundation.
3. The new building is 40m x 166m. The ground floor will be served as warehouse with two covered car parks as loading/unloading area. For loading/unloading purpose, the ground floor level is proposed to be raised by 1.2m. The first floor will be used for office.
4. To facilitate future alteration, the client asks for an open plan building. No structural wall is allowed for stair/lift core and anywhere.
5. The minimum column spacing (centre to centre) is 8m, except for Warehouse A and C, where column spacing should be widened to 16m for storage of large machinery. Also, no column is allowed at the car parks.
6. Glazing façade is proposed at office with peripheral columns of 500mm setback from building edge.
7. Minimum requirements on clear headroom (clear height of all structures, 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>
1/F	Office	3.8	0.6
G/F	Warehouse	4.0	0.4
G/F	Car park	5.2	0.4

8. A minimum 2-hour fire resistance rating is required for all structural elements.

9. An open footbridge with glass balustrade is proposed on 1/F for staff passage from the existing building over the 6m-width driveway. A clear 5.2m headroom of driveway shall be maintained.

Imposed Loads

10. The imposed loads shall be in accordance with the latest version of the Code of Practice for Dead and Imposed Loads in Hong Kong with the Specific Use below:

Car park	Areas accessible to vehicles not exceeding 30,000 kg gross weight
Warehouse	General storage with storage height in accordance with clear headroom
Office	Offices for general use
Roof	Inaccessible roof

Wind Loads

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

Site Conditions

12. Ground conditions are:

+6mPD to +5mPD	Loose fill, SPT N-value < 10.
+5mPD to -14mPD	Medium dense sand with SPT N-value from 20 to 50.
-14mPD and below	Strong completely decomposed granite in the form of dense to very dense coarse sand, SPT N-value ranges from 100 to 150.

Groundwater is encountered at 5m below ground level.

Omit from Consideration

13. Detailed layout and design of the structure inside the lift shaft and staircase core.

Section A

- a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable solutions for the proposed extension including two viable foundation schemes. Indicate clearly the functional framing, load transfer, serviceability 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 structure will resist wind load including detailed description of the structural wind loads and design assumption. Prepare a detailed wind load calculation and stability checking for the proposed extension.

(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 framing plans, sections and elevations to show the dimensions, layout and disposition of the structural elements and critical details including fire protection for estimating purposes.

(18 marks)

- e. Prepare footbridge details including (1) connection to existing logistic centre, and (2) glass balustrade.

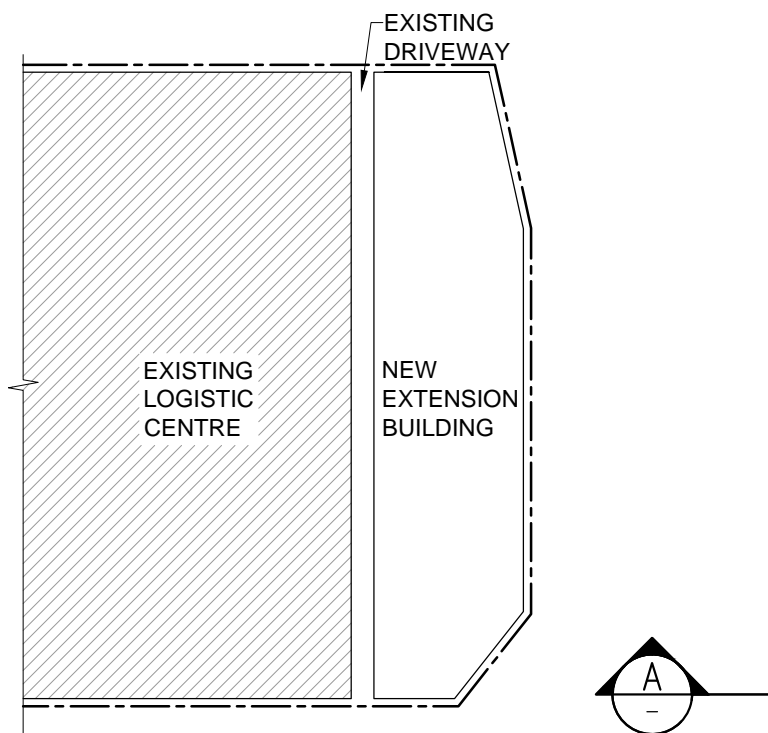
(6 marks)

- f. Prepare a detailed method statement covering essential activities for the safe construction of the new building including the formation of opening at the existing curtain wall of logistic centre for footbridge connection.

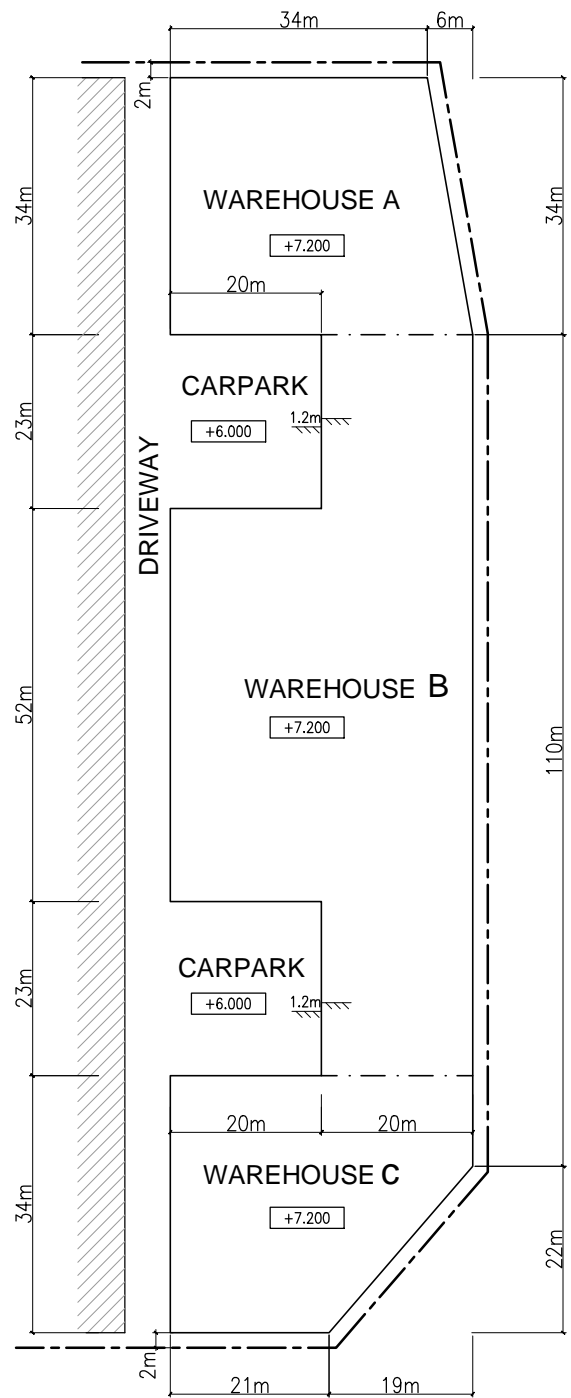
(8 marks)

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

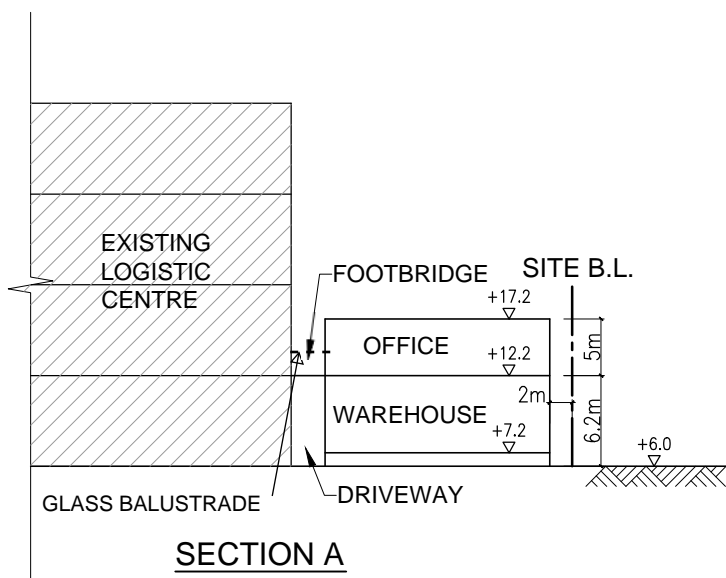
(8 marks)



BLOCK PLAN



G/F PLAN



SECTION A

Figure Q3

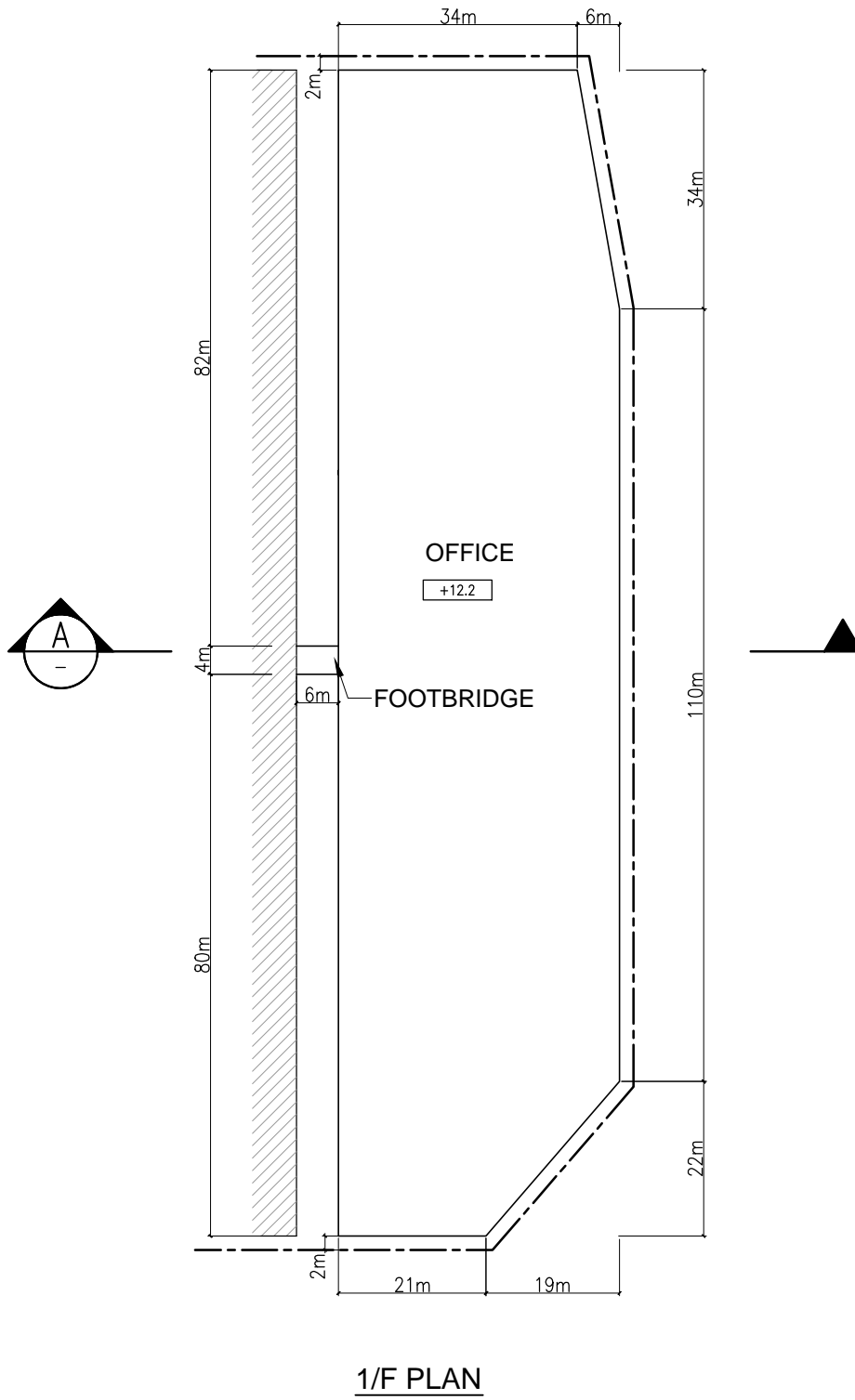


Figure Q3

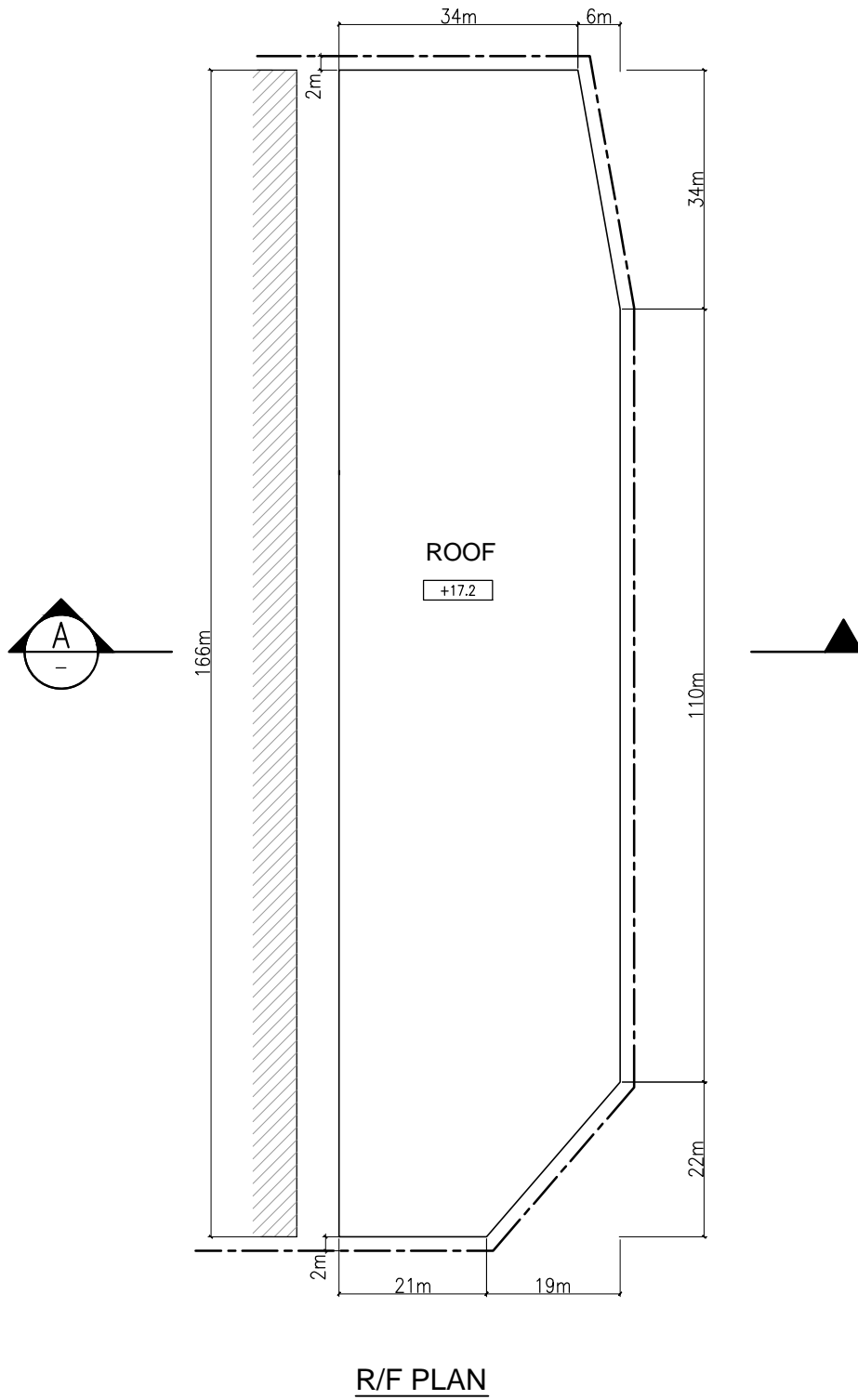


Figure Q3

Question 4 Office/Hotel Development

Client's Requirements

The following client's requirements must be met:

1. A 40-storey Office/Hotel development is to be built at Central, HK. See figure Q4.
2. No foundation can be built within the 3m MTR protection zone.
3. No vertical structural element can be placed within the "Column Free Zone" as indicated on plan.
4. All vertical structural elements, if any, must be affixed to the partition wall inside the hotel room/s.
5. Minimum column spacing (centre to centre) at office floors is to be 10m.
6. 250mm curtain wall along the perimeter of the building is to be allowed.
7. No part of the structure, including foundations, can be built outside the building line.
8. Minimum requirements on clear headroom (clear height of all structures, 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>
Basement	Car park	3.0	0.5
G/F	Main Entrance	4.5	0.5
1/F to 20/F	Office	3.0	0.5
21/F	Refuge floor	3.0	0.5
22 to 40/F	Hotel	3.0	0.5

9. A minimum 2-hour fire resistance rating is required for all structural elements.

Imposed Loads

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

Wind Loads

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

Site Conditions

12. The site is located at Central, HK.

13. Ground conditions are:

Ground level – 10m Fill, SPT N-value = 10.

10 m – 30 m Marine Deposit, SPT N-value = 4.

30 m – 40 m Alluvium, SPT N-value = 15.

40 m – 50 m CDG with SPT N-value varies from 30 to 200.

Grade III rock with total core recovery more than 85% of the grade is found at 50m below ground level.

Groundwater is encountered at 3m below ground level.

Omit from Consideration

14. Detailed layout and design of car park.

Section A

- a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable solutions for the proposed Office/Hotel including two viable foundation schemes, with due consideration of the existing MTR tunnel. 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 structure will resist wind load including detailed description of the structural wind loads and design assumption. Prepare a detailed stability checking of the structure with wind load calculation including estimation of building deflection to meet statutory requirement for the proposed Office/Hotel.

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

(20 marks)

- e. Prepare a detailed method statement covering essential activities for the safe construction of the Office/Hotel including foundation works, with due consideration of the existing MTR tunnel.

(10 marks)

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

(10 marks)

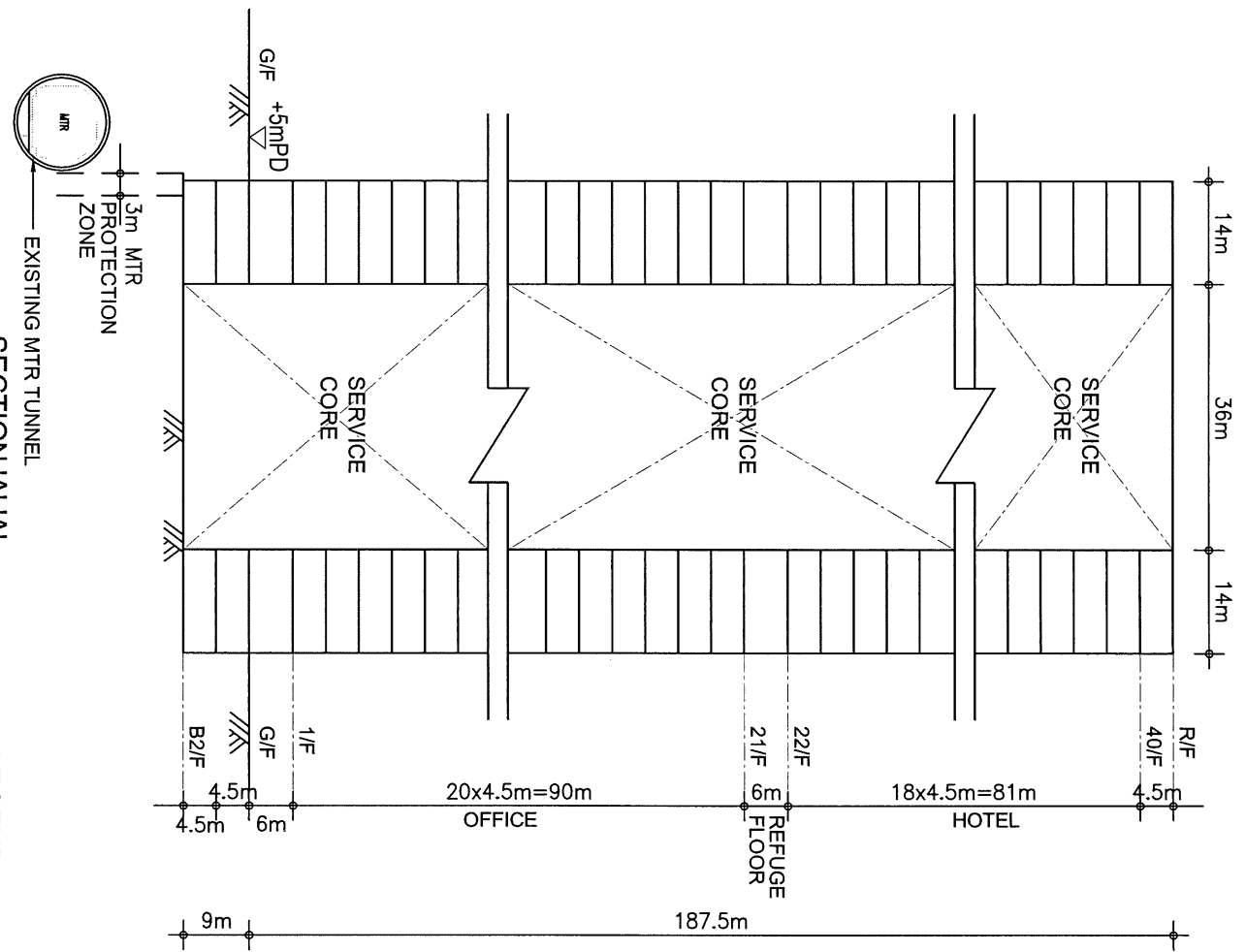
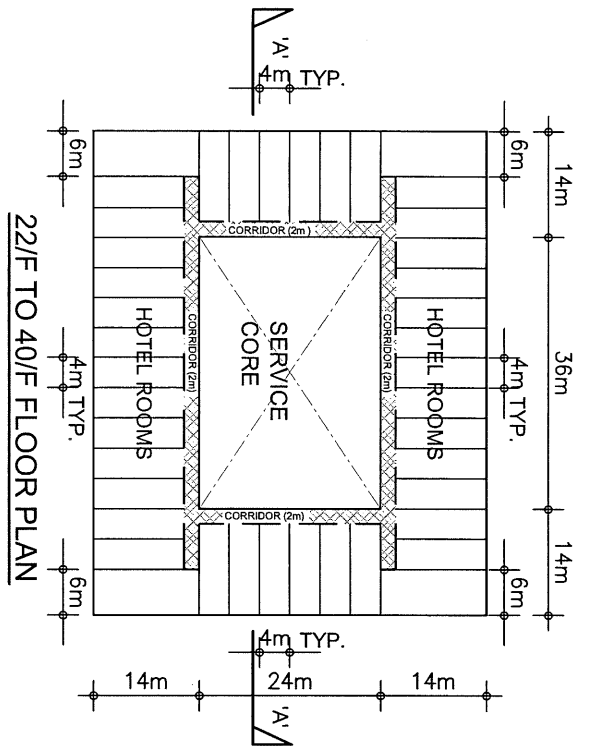
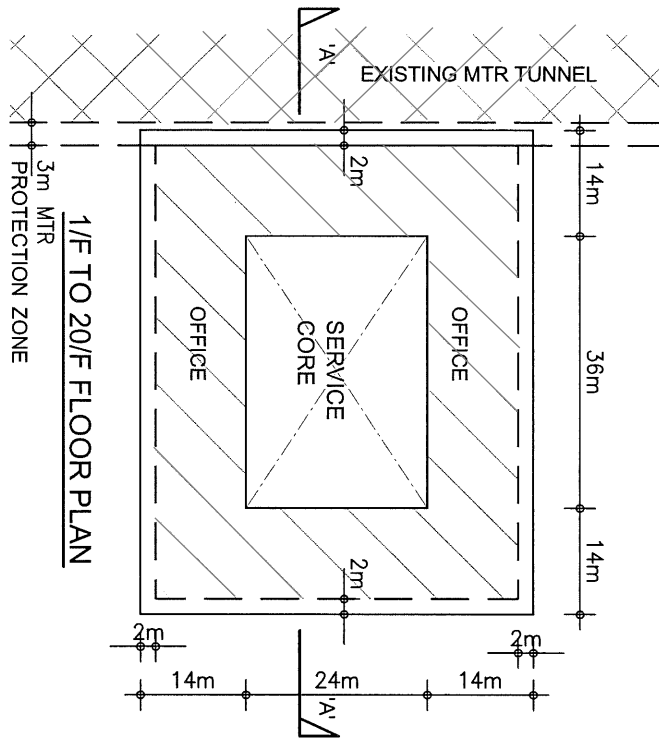


Figure Q4

Question 5 Bridge over Channel

Client's Requirements

The following client's requirements must be met:

1. A Road Bridge carrying a dual carriageway and footpath is to be built over an existing channel with footpaths and utilities zone at the channel bank. See figure Q5.
2. No temporary and permanent structures are to be placed within the channel as shown on Section A-A in figure Q5. The high water level of the channel is to be +4.5mPD at wet season (April to Oct).
3. The footpaths at the top of channel need to be kept at all times and the utilities zone needs to be protected and maintained throughout the construction.
4. The design of the structure should be kept to a minimum height with a maximum gradient of 1 in 12 due to environmental reason.
5. Minimum requirements on clear headroom over footpaths, utilities and maintenance zone are as follows:

<u>Location</u>	<u>Min. Clear Headroom (m)</u>
Footpaths	3.5m
Utilities and maintenance zone	4.5m
Height of bridge soffit at abutment	2.0m

6. The construction is planned to complete in 2 years and to be started in January to avoid the wet season. Incentives are planned for shortening the programme of construction to speed up the works.

Design Requirements

7. The structural design shall be in accordance with the latest version of the Structures Design Manual for Highways and Railways published by the Highways Department of the HKSAR Government.

Imposed Loads

8. The imposed loads and highway loadings shall be in accordance with the latest version of the Structures Design Manual for Highways and Railways.

Wind Loads

9. The wind loads shall be in accordance with requirements in the latest version of the Structures Design Manual for Highways and Railways.

Site Conditions

10. The site is located at rural open area with Degree 3 of exposure to wind.
11. Ground conditions are:

Ground level – 4m Fill, SPT N-value = 0 – 5.

4m – 8m Medium dense soil, SPT N-value = 10 – 30.

8m – 15m Very dense soil, SPT N-value >50.

15m and below Moderately decomposed, moderately strong to moderately weak rock of material weathering grade III or better, with TCR > 50%.

Groundwater is encountered at 3.5m below ground level.

Omit from Consideration

12. Design calculations for approach ramp and containment parapet.
13. Detailed layout and design of approach ramp.

Section A

- a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable solutions for the proposed road bridge 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 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 road bridge.

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

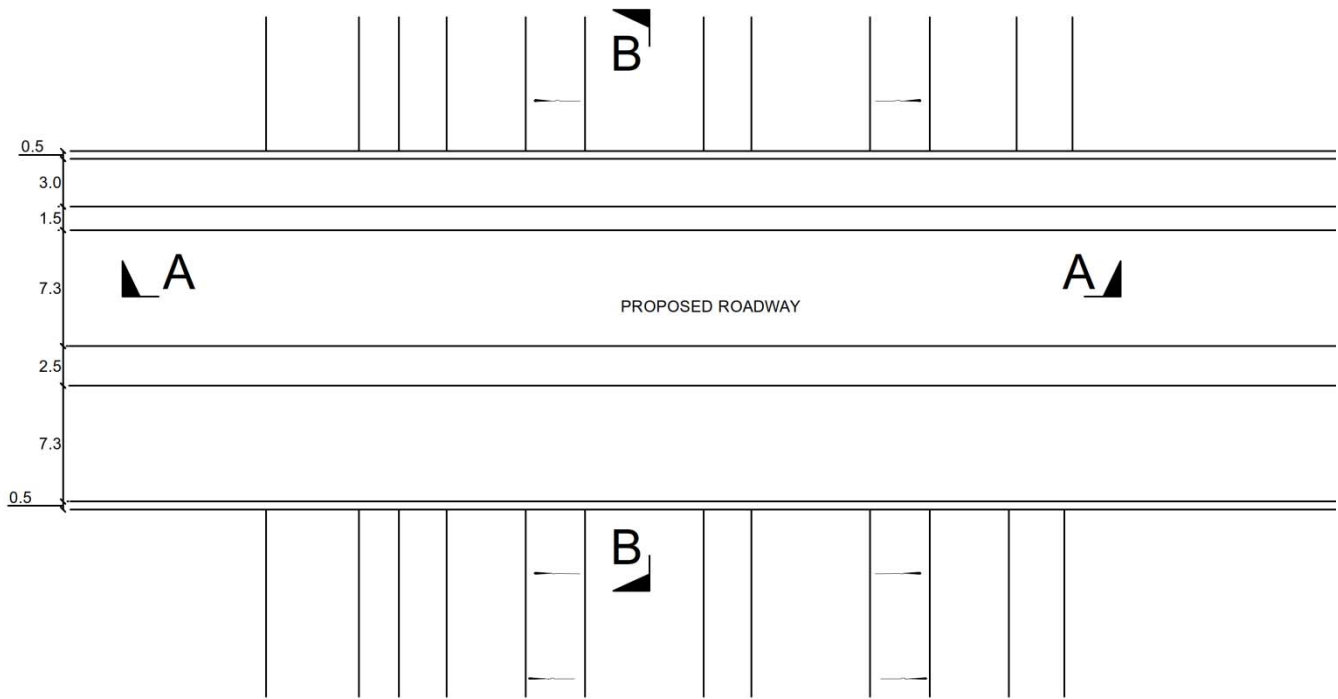
(20 marks)

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

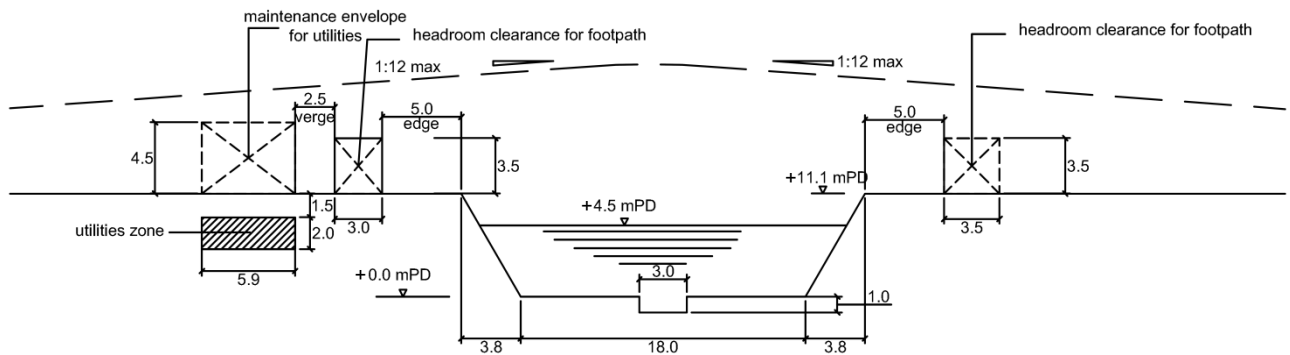
(10 marks)

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

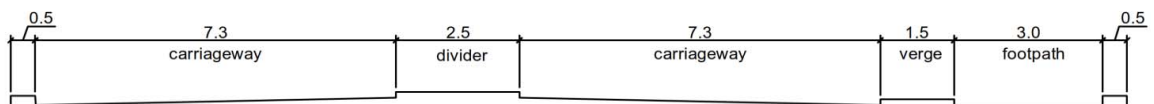
(10 marks)



PLAN



SECTION A-A



SECTION B-B

Note: All units are in metre

Figure Q5