The Institution of Structural Engineers

Chartered Membership Examination

Friday 25 April 2014

Structural Engineering Design and Practice

09.30 – 13.00 and 13.30 – 17.00 (Discussion between individuals is not permitted during lunch period). A period of fifteen minutes is provided for reading the question paper, immediately before the commencement of the examination. Candidates are not permitted to write in answer sheets, or on drawing paper or to use a calculator during this time. Candidates must satisfy the Examiners in ONE question.

Important

The written answer to the question selected and any A3 drawings must bear the candidate's number and the question number at the bottom of the page. Only the answer sheets supplied by the Institution may be used. The candidate's name should not appear anywhere in the script.

Notes to Candidates

1. TO PASS THE EXAMINATION, CANDIDATES MUST SATISFY THE EXAMINERS IN BOTH PARTS OF THE QUESTION ATTEMPTED.
2. Examiners will only mark work written by hand during the examination.
3. A fair proportion of marks will be awarded for the demonstration of an understanding of fundamental engineering concepts, as distinct from calculation of member forces and sizes. NOTE: In the calculation part of all questions, establishing "form and size" is taken to mean compliance with all relevant design criteria, i.e. bending, shear, deflection, etc.
4. In all questions 50 marks are allocated to Section 1 and 50 marks to Section 2.
5. The Examiners are looking for sound structural designs. It should also be remembered that aesthetics, economy and function are important in any competent engineering scheme.
6. Any assumptions made and the design data and criteria adopted must be stated.
7. Portable computers or programmable calculators may be used but sufficient calculations must be submitted to substantiate the design, and these should be set out as in practice.
8. Good clear drawings and sketches are required; they should show all salient and structural features to suitable scales and should incorporate adequate details.
9. Candidates will not be allowed to include any previously prepared calculations, notes, sketches, diagrams, computer output or other similar material in their answer sheets or A3 drawings. Any previously prepared information submitted by candidates will be ignored by the examiners.
10. Strictly no external electronic contact is allowed between a candidate and anyone outside the examination venue. Mobile phones must be switched off throughout the duration of the examination.
11. This paper is set in SI Units.

Now read 'Reminder' on page 3.

Chartered Membership Examination, a reminder from your Examiners

The work you are about to start has many features in common with other examinations which you have tackled successfully but it also has some which are unusual.

As in every examination you must follow carefully the NOTES FOR CANDIDATES set out for your guidance on the front cover of this paper; allocate the available time sensibly and set out your work in a logical and clear way.

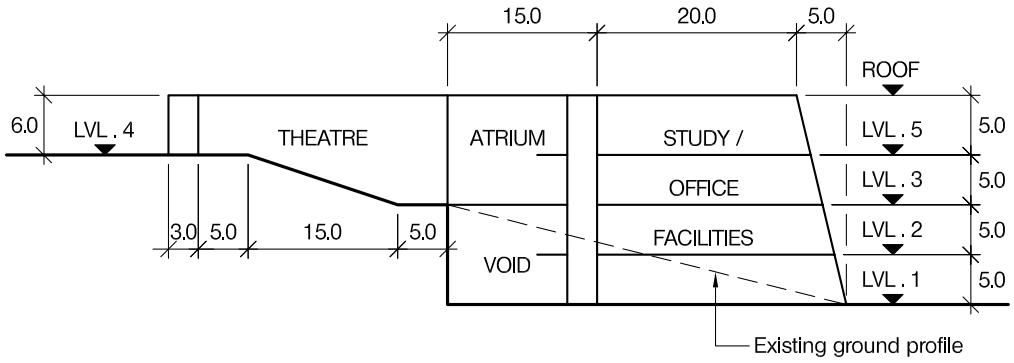
The unusual requirement of the examination is that you demonstrate the validity of the training and experience that you have acquired in recent years. The Institution must be satisfied that you are able to bring all the various skills you are expected to possess to the effective solution of structural design problems – whether or not the problem is presented in terms that are within your actual experience.

Chartered Structural Engineers must have the ability to design and a facility to communicate their design intentions. Where you are required to list and discuss possible structural solutions you must show by brief, clear, logical and systematic presentation that you understood the general structural engineering principles involved.

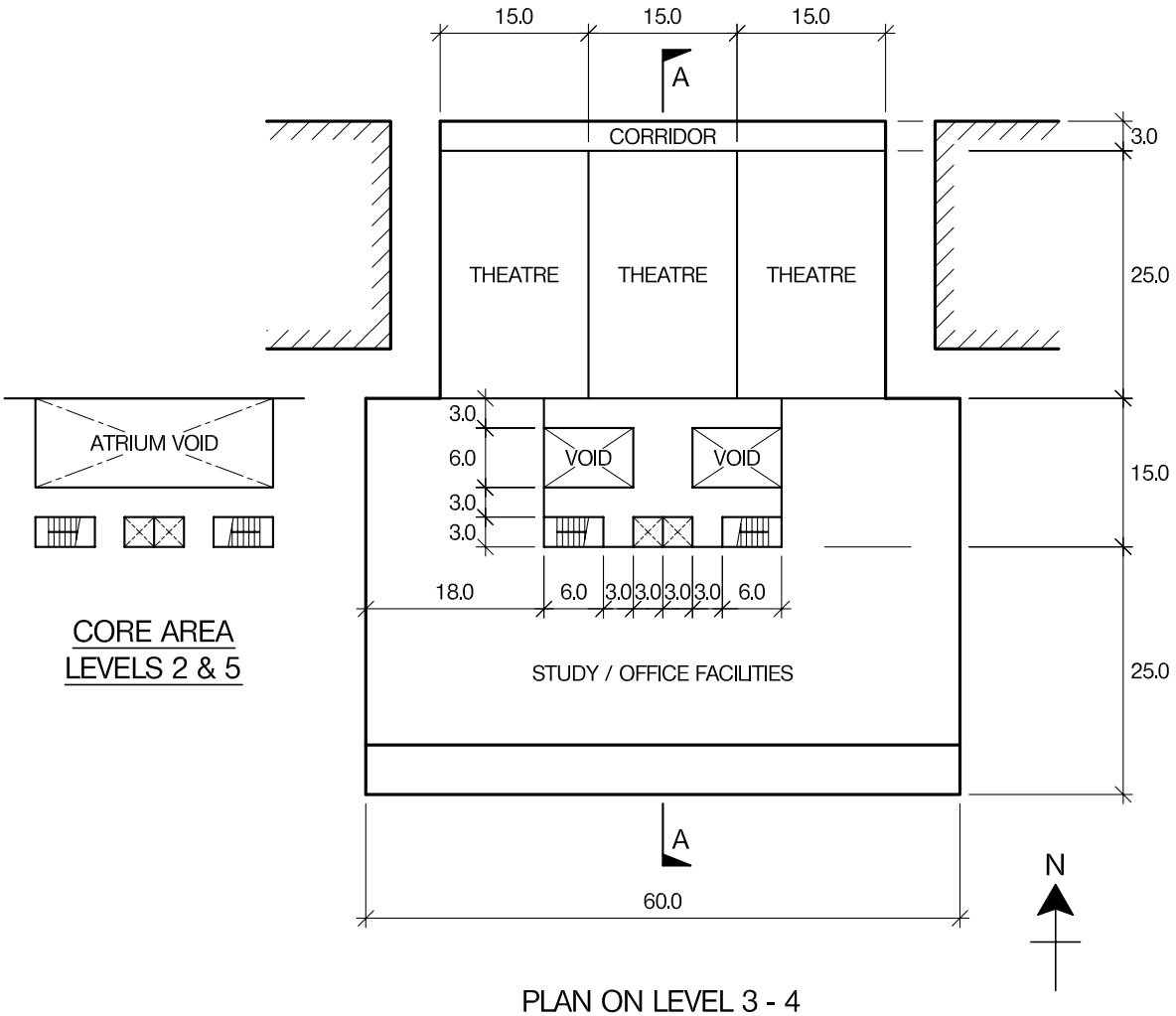
In selecting and developing your design you should also remember the guidance given in the Institution's report, Aims of Structural Design, and in particular:

(1) "the structure must be safe",
(2) "a good design has certain typical features – simplicity, unity and necessity",
(3) "the structure must fulfil its intended function".

If you have difficulty in deciding the correct interpretation of a question, pay particular attention to point 6. notes to candidates, on the front cover. The examiners will take into account your interpretation – and the design you base on this – if this is clearly stated at the beginning of your answer.



SECTION A - A



CORE AREA
LEVELS 2 & 5

PLAN ON LEVEL 3 - 4

NOTE: All dimensions are in metres

FIGURE Q1

Question 1. University building

Client's requirements

1. A new building at a university consisting of three lecture theatres and four floors of study/office facilities. See Figure Q1.
2. The building is to be constructed on a sloping site and will be adjacent to two existing buildings. A 5.0m clearance for access all round the new building is required.
3. The maximum permitted overall height of the lecture theatres above level 4 is 6.0m. A minimum clear internal height of 4.5m is required. No columns are permitted within the lecture theatres.
4. Each floor-to-floor height in the study/office area is to be 5.0m maximum. Clear minimum internal floor-to-ceiling heights of 3.5m are required. A clear 200mm service zone is required above each floor between the ceiling and the underside of the structure.
5. No more than one row of columns is permitted between the core area and the fully-glazed south elevation. Columns to the south elevation are to be at least 6.0m apart.
6. Vertical structural elements around the lecture theatres are to be concealed within the internal blockwork walls.

Imposed loading

7.

Roof	1.5kN/m^2
Study/offices floor loading	3.5kN/m^2
Lecture theatre floor loading	4.0kN/m^2

Site conditions

8. The site is located on the outskirts of a large city. Basic wind speed is 40m/s based on a 3-second gust; the equivalent mean hourly wind speed is 20m/s.
9. Ground conditions vary linearly with the existing slope surface.

Ground level – 1.0m	Topsoil and fill
1.0m – 3.0m	Silty sand, N=8
3.0m – 12.0m	Dense silty sand, N=35
Below 12.0m	Rock, allowable safe bearing pressure 3500kN/m^2

Ground water was not encountered.

Omit from consideration

10. Detailed design of the lift/elevator shafts and stairs.

SECTION 1 (50 marks)

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

b. After the design has been completed the client wishes to add an additional floor of study/office space above the building and over its whole area. Write a letter to the client explaining the effects on your design. (10 marks)

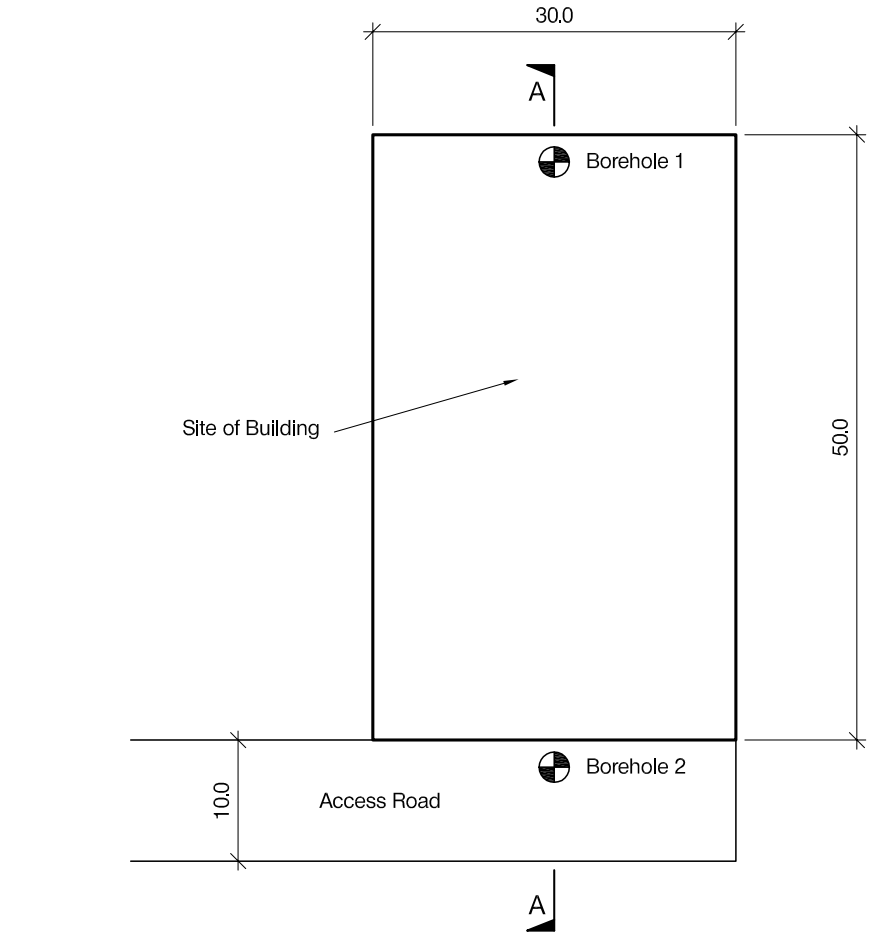
SECTION 2 (50 marks)

For the solution recommended in Section 1(a):

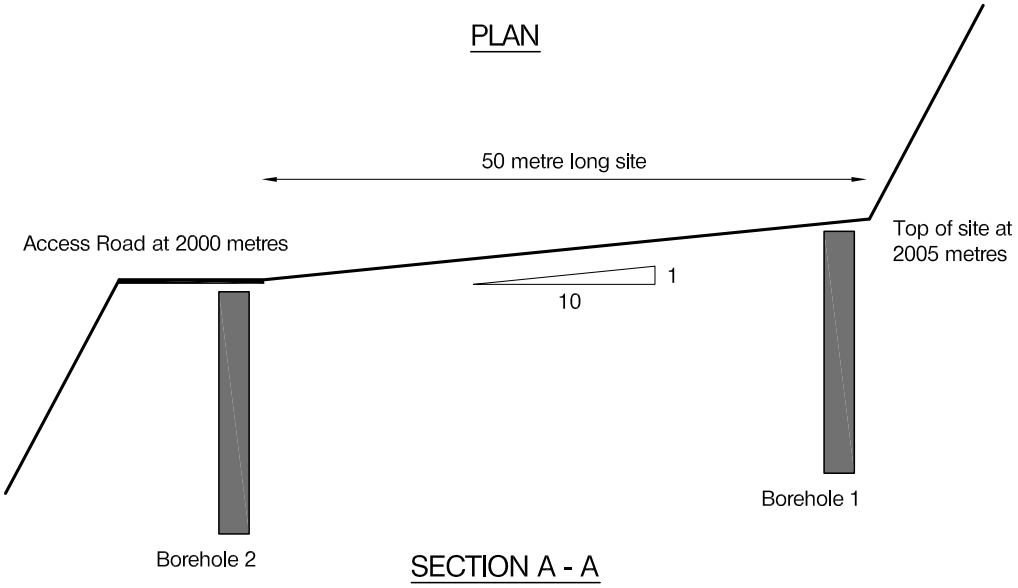
c. Prepare sufficient design calculations to establish the form and size of all the principal structural elements including the foundations. (20 marks)

d. Prepare general arrangement 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 for the safe construction of the building and an outline construction programme. (10 marks)



PLAN



SECTION A - A

NOTE: All dimensions are in metres

FIGURE Q2

Question 2. Garage for snow ploughs

Client's requirements

1. A new garage to store four snow ploughs.
2. Each snow plough requires a parking space 10.0m wide by 10.0m long. Clear headroom of 5.0m is required throughout. No structural elements may intrude into this space.
3. The site is 30.0m wide and 50.0m long. See Figure Q2. An access road serves the site on one side. The site and access road are surrounded on all sides by steep slopes.
4. The site slopes upwards away from the access road at a slope of 1 in 10. See Figure Q2. The floor of the garage is required to be level.
5. Sufficient doors must be provided to the garage so that three snow ploughs can exit to the access road at all times, even if the fourth plough is under repair. The door opening must have a clearance of at least 10.0m wide and 5.0m high.
6. Access to the site is via a single-track road which is usable, because of weather conditions, for only four months of the year. The longest length of a structural element that can be delivered to the site in one piece is 7.0m.

Imposed loading

7. Snow loading — Density of snow: 2.0kN/m^3. The maximum snow depth based on a 50-year return period is 7.0m. The horizontal load imposed by snow may be taken as 30% of the vertical load.
   Snow plough loading — 2.0kN/m^2

Site conditions

8. The site is located in a mountainous location at an altitude of 2000m. Basic wind speed at sea level is 46.0m/s based on a 3-second gust; the equivalent mean hourly wind speed is 23.0m/s.
9. **Borehole 1 (top of hole at 2005m altitude)**

Ground level – 0.2m	Topsoil
Below 0.2m	Rock, allowable safe bearing pressure 400kN/m^2

Borehole 2 (top of hole at 2000m altitude)

Ground level – 4.0m	Gravel, N=20
Below 4.0m	Rock, allowable safe bearing pressure 800kN/m^2

Groundwater was not encountered in either borehole.

Omit from consideration

10. Detailed design of door mechanism.

SECTION 1 (50 marks)

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

b. After the design has been completed there is a severe winter which restricts use of the access road to only two months during the summer. Expert meteorological opinion suggests this may happen more frequently in the future. Write a letter to your client explaining the implications of this information on the construction of your proposed structure. (10 marks)

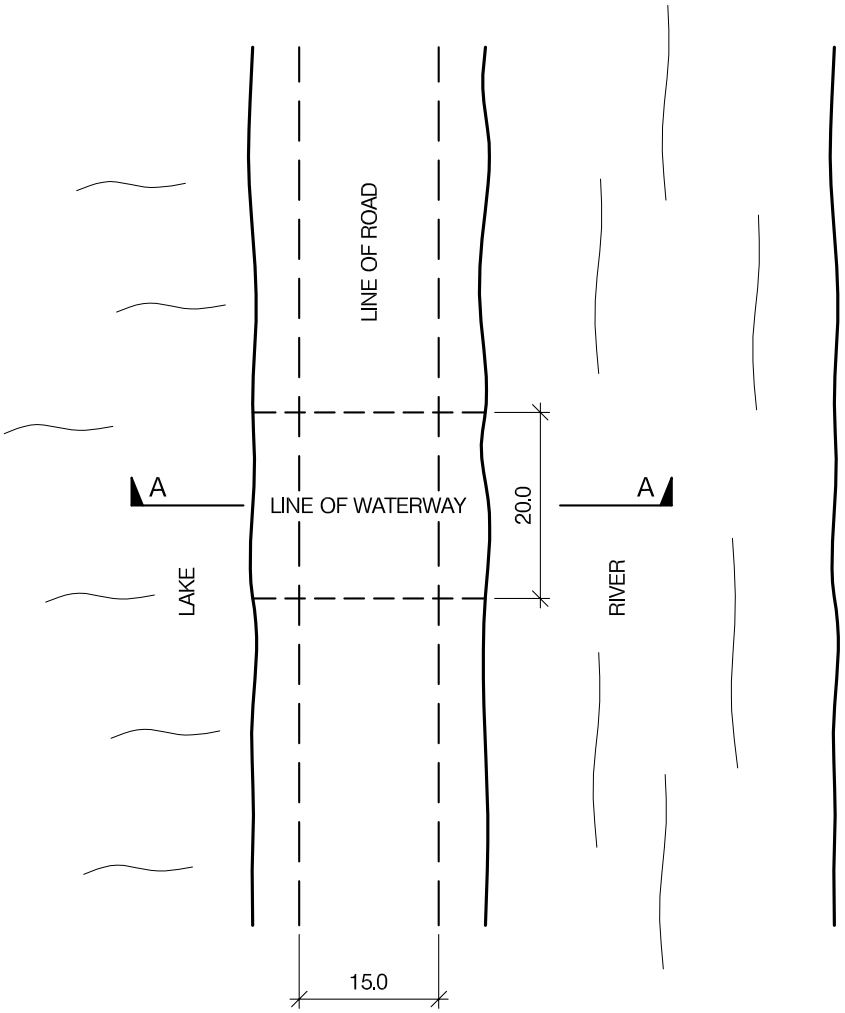
SECTION 2 (50 marks)

For the solution recommended in Section 1(a):

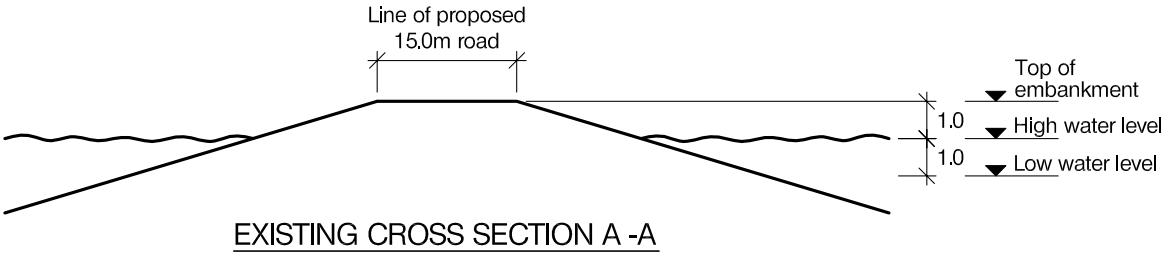
c. Prepare sufficient design calculations to establish the form and size of all the principal structural elements including the foundations. (20 marks)

d. Prepare general arrangement 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 for the safe construction of the building and an outline construction programme. (10 marks)



PLAN



EXISTING CROSS SECTION A -A

NOTE: All dimensions are in metres

FIGURE Q3

Question 3. Vehicle crossing for waterway

Client's requirements

1. A 20.0m wide waterway is to be cut through an existing embankment to allow boats to sail between a river and a lake. An access road is to be constructed on top of the embankment and a vehicle crossing is required over the waterway. See Figure Q3.
2. Minimum headroom required for road traffic is 5.0m. Boats will generally not exceed 4.0m high measured from water level; however, the design needs to make provision for occasional boats up to 6.0m high over the central third of the width of the waterway. The maximum allowable road gradient is 1 in 24.
3. Due to planning constraints, no new fixed construction, other than non-structural vehicle barriers, is permitted to exceed 6.0m in height above the top of the existing embankment.
4. The lake and river are linked away from the site so that water levels are always the same in each. High water level is 1.0m below the existing embankment level. Low water level is 2.0m below the existing embankment level. Boats must be able to pass along the waterway in both situations. The minimum depth of water required is 3.0m at any time.

Imposed loading

5. Road 10.0kN/m^2

Site conditions

6. The site is located in open countryside. Basic wind speed is 46.0m/s based on a 3-second gust; the equivalent mean hourly wind speed is 23.0m/s.
7. Ground conditions:
   Clay C = 200kN/m^2
   Ground water was not encountered.

Omit from consideration

8. Longitudinal imposed loading
   Embankment slope stability checks

SECTION 1 (50 marks)

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

b. After completion of the design the client informs you that high water level can rise to 0.5m below existing embankment level and low water level can fall to 3.0m below the existing embankment level. Write a letter to the client advising him of the implications on your design. (10 marks)

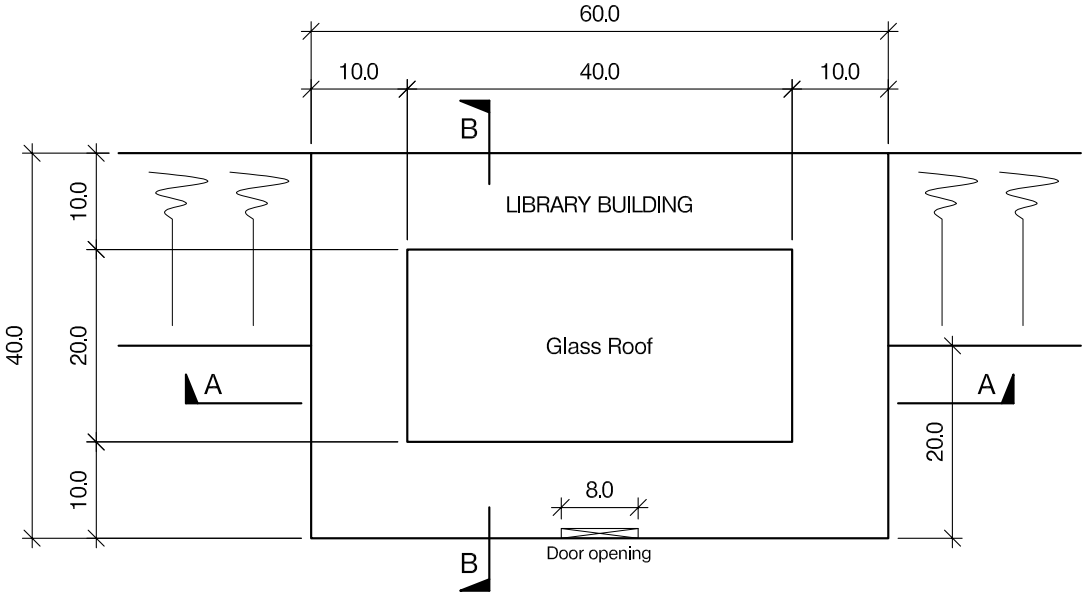
SECTION 2 (50 marks)

For the solution recommended in Section 1(a):

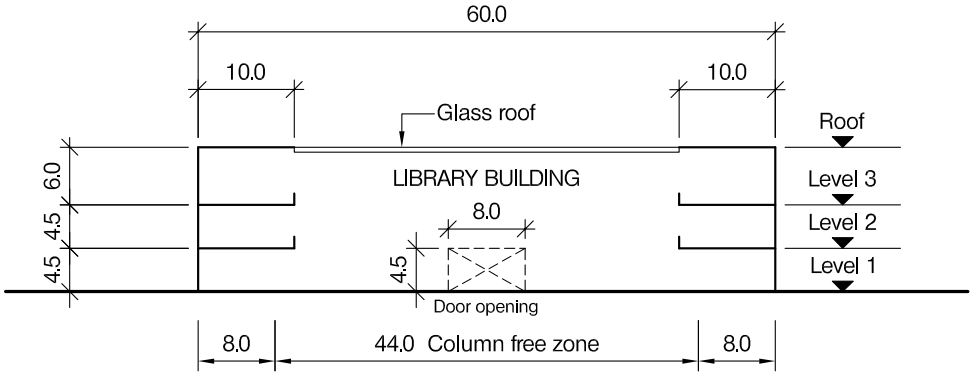
c. Prepare sufficient design calculations to establish the form and size of all the principal structural elements including the foundations. (20 marks)

d. Prepare general arrangement plans, sections and elevations to show the dimensions, layout and disposition of the structural elements and critical details for estimating purposes. (20 marks)

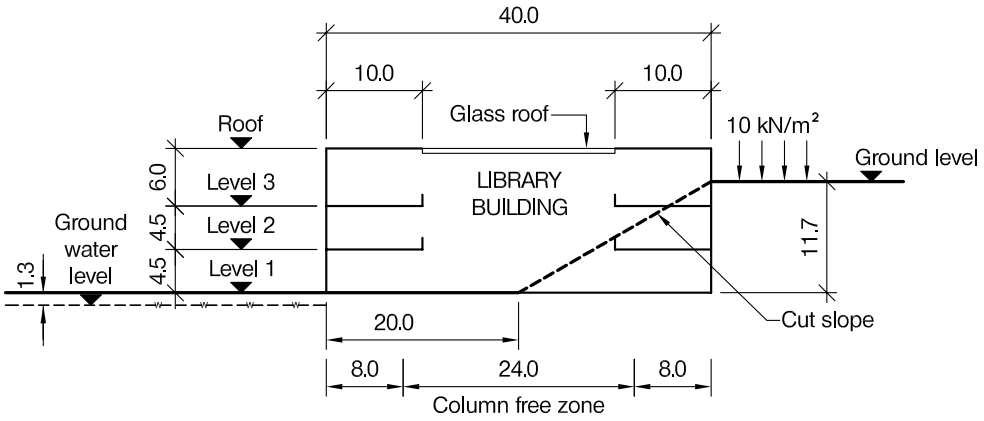
e. Prepare a detailed method statement for the safe construction of the works and an outline programme. (10 marks)



ROOF PLAN



SECTION A - A



SECTION B - B

NOTE: All dimensions are in metres

FIGURE Q4

Question 4. Library building

Client's requirements

1. A library building is to be built on a site cut into a hillside. See Figure Q4.
2. The building is to be three storeys high. Floor-to-floor heights are to be 4.5m for the lower two storeys and 6.0m for the upper storey.
3. A 40.0m x 20.0m area in the centre of the roof is to be glazed to provide natural light.
4. No columns are permitted within the 44.0m x 24.0m column-free zone indicated in Figure Q4.
5. A minimum fire resistance period of two hours is required for the structural elements.

Imposed loading

6.

Floors	7.5kN/m^2
Roof	2.0kN/m^2
Surcharge at top of hill	10.0kN/m^2

Site conditions

7. The site is located in a city centre. Basic wind speed is 40.0m/s based on a 3-second gust; the equivalent mean hourly wind speed is 20.0m/s.
8. Ground conditions:

Ground level – 12.0m	Dense silty sand, Ø = 35 degrees
12.0m – 24.0m	Dense sand, N=30
Below 24.0m	Rock, characteristic compressive strength 5000kN/m^2

Groundwater was encountered at 1.3m below ground level.

Omit from consideration

9. Detail design of lift/elevator shaft and stairs.
Slope stability checks
Roof glazing design

SECTION 1 (50 marks)

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

b. After completion of the design, the client advises that he wants to add a 4.5m deep basement to the building for archive storage. Write a letter to your client explaining the structural implications. (10 marks)

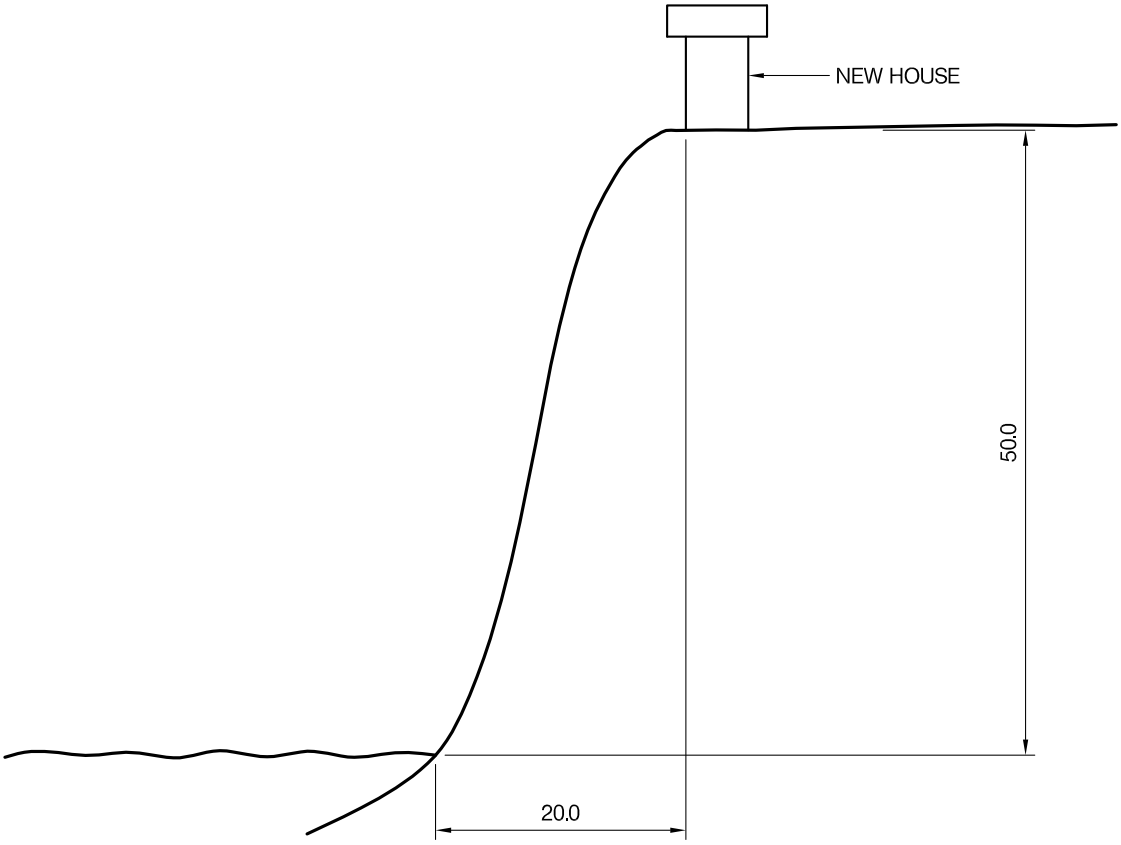
SECTION 2 (50 marks)

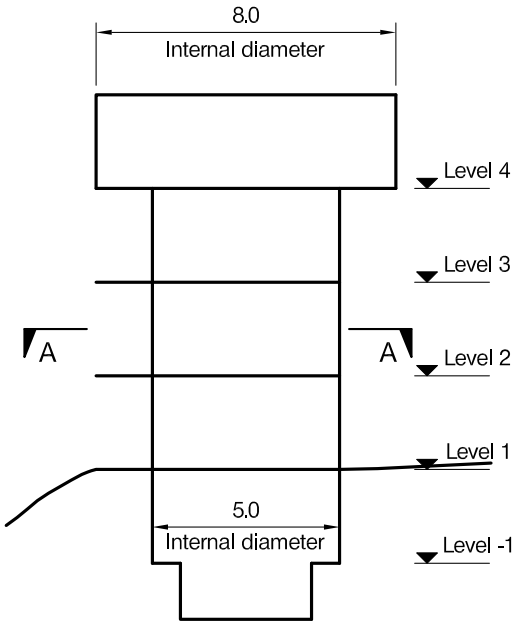
For the solution recommended in Section 1(a):

c. Prepare sufficient design calculations to establish the form and size of all the principal structural elements including the foundations. (20 marks)

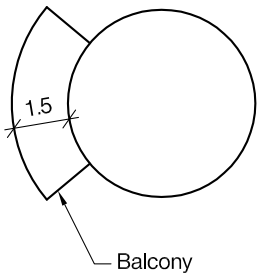
d. Prepare general arrangement plans, sections and elevations to show the dimensions, layout and disposition of the structural elements and critical details for estimating purposes. (20 marks)

e. Prepare a detailed method statement for the safe construction of the works and an outline programme. (10 marks)





SECTION



SECTION A - A

NOTE: All dimensions are in metres

FIGURE Q5

Question 5. Cliff-top House

Client's requirements

1. A new house built on a cliff top overlooking the sea. See Figure Q5.
2. The house is to be circular in plan and is to have four upper storeys and a basement. The top storey is to be 8.0m diameter with views in all directions; all other storeys are 5.0m diameter. 1.5m wide balconies looking towards the sea are required at levels two and three.
3. There is to be a 3.5m diameter x 1.5m deep circular swimming pool in the basement.
4. No internal columns are allowed above level four.
5. The site is at the end of a 1.5km long, narrow, winding lane.

Imposed loading

6. Floors 1.5kN/m^2
   Balconies 1.5kN/m^2
   Roof 1.5kN/m^2
   Horizontal loading on balcony balustrade 0.75kN/m at 1.1m above balcony level.

Site conditions

7. The site is located in open countryside. Basic wind speed is 52.0m/s based on a 3-second gust; the equivalent mean hourly wind speed is 26.0m/s.
8. Ground conditions:
   Ground level – 0.5m Made ground
   0.5m - depth Fissured sandstone, allowable safe bearing pressure 1500kN/m^2
   Groundwater is not present

Omit from consideration

9. Detail design of stairs.

SECTION 1 (50 marks)

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

b. The design has been completed and initial site works begun when the clients announce that they are expecting twins and would like to add an additional 5.0m diameter storey below the 8.0m diameter storey. Write a letter to the clients advising them of the structural implications. (10 marks)

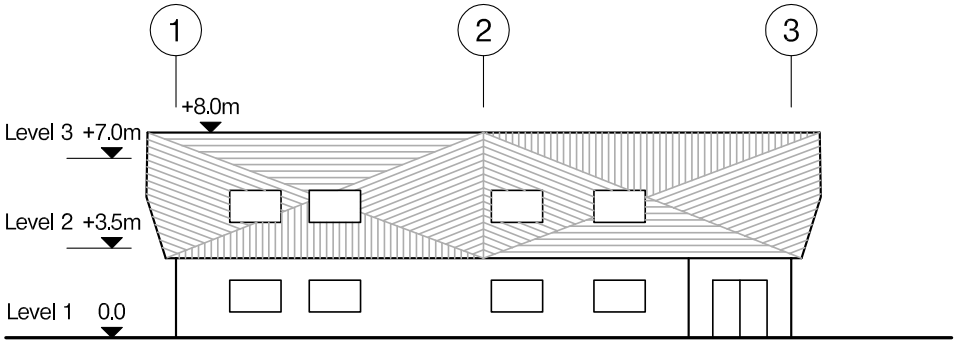
SECTION 2 (50 marks)

For the solution recommended in Section 1(a):

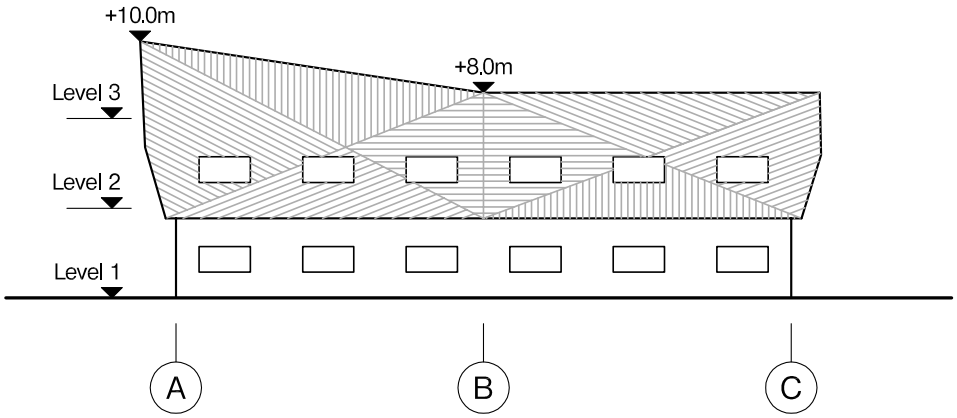
c. Prepare sufficient design calculations to establish the form and size of all the principal structural elements including the foundations. (20 marks)

d. Prepare general arrangement plans, sections and elevations to show the dimensions, layout and disposition of the structural elements and critical details for estimating purposes. (20 marks)

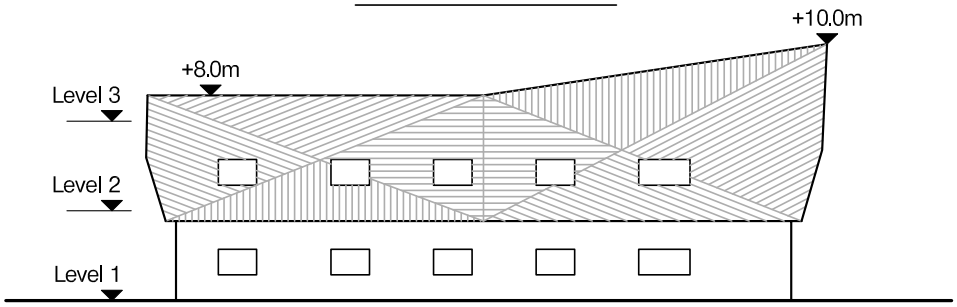
e. Prepare a detailed method statement for the safe construction of the building and an outline programme. (10 marks)



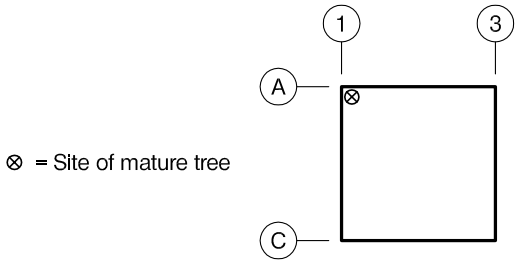
ELEVATION GRID C



ELEVATION GRID 1

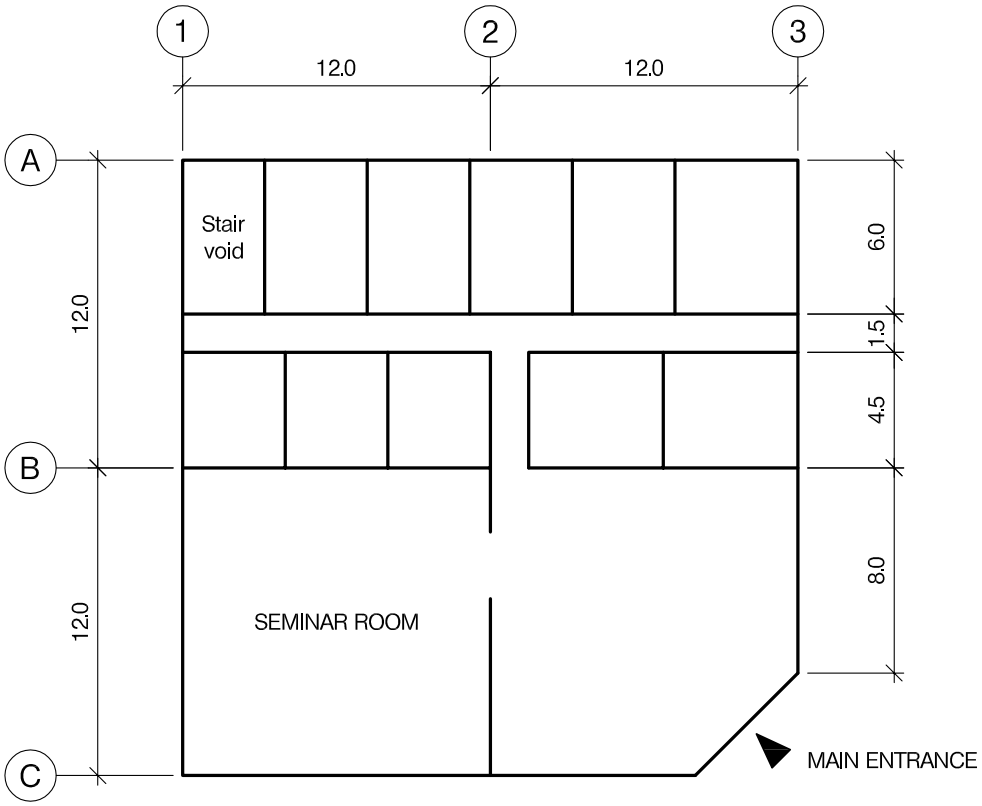


ELEVATION GRID A

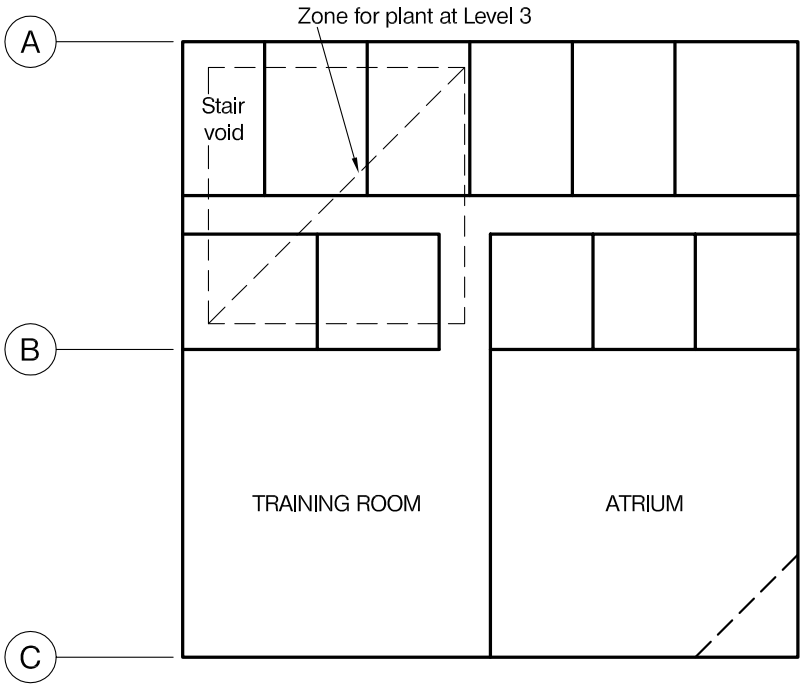


NOTE: All dimensions are in metres

FIGURE Q6-1



LEVEL 1 PLAN



LEVEL 2 PLAN

NOTE: All dimensions are in metres

FIGURE Q6-2

Question 6. Health centre

Client's requirements

1. A health centre with consulting rooms, treatment rooms and training facilities. See Figures Q6-1 and Q6-2.
2. A minimum floor to ceiling height of 2.6m at each level is required. No columns are permitted outside the Level one footprint in the entrance area.
3. Above level two the building is to be clad in timber. Comfort cooling plant 1.2m high is to be located at roof level (level three) which the architect requires to be screened by extending the facade.
4. The only site available requires the removal of a 10.0m high mature broadleaf tree located at corner A1.

Imposed loading

5.

Floors	2.5kN/m^2
Roof	0.8kN/m^2
Comfort cooling plant	5.0kN/m^2

Site conditions

6. The site is located in open countryside. Basic wind speed is 46m/s based on a 3-second gust; the equivalent mean hourly wind speed is 23m/s.
7. Ground conditions:

Ground level – 0.3m	Granular fill
0.3m – 2.5m	High plasticity clay, C = 40kN/m^2
2.5m – 5.0m	Sands and gravels, N = 11
Below 5.0m	Weathered sandstone

Groundwater is not present

Omit from consideration

8. Detail design of stairs.

SECTION 1 (50 marks)

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

b. After the building has been completed and is in use, the client asks for the atrium at level two to be infilled with a floor to provide additional space for consulting rooms. Write a letter to your client explaining the structural implications and how this might be achieved while maintaining full operation of the health centre. (10 marks)

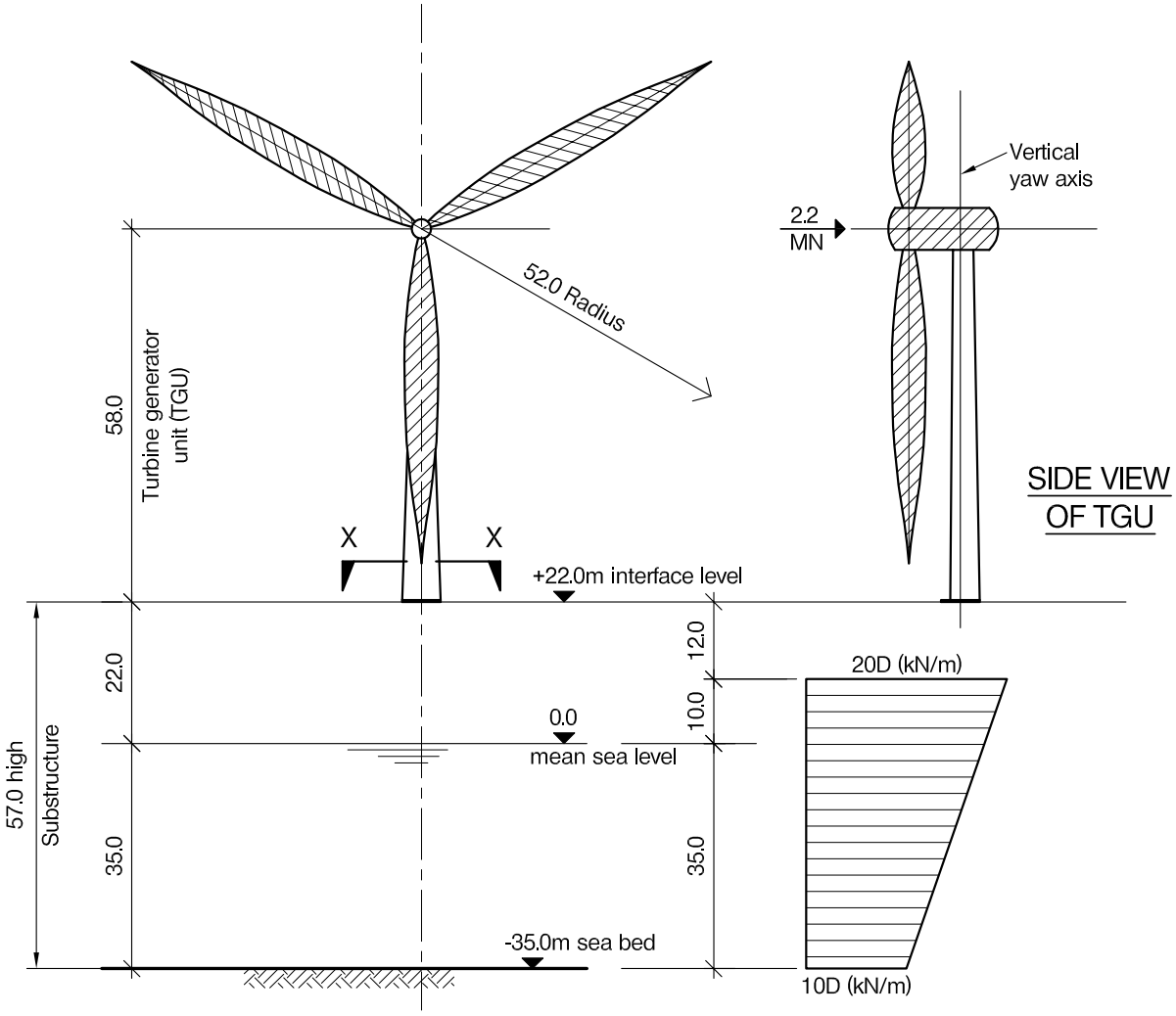
SECTION 2 (50 marks)

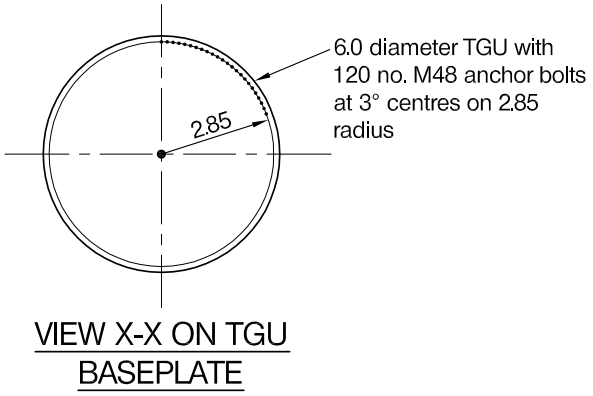
For the solution recommended in Section 1(a):

c. Prepare sufficient design calculations to establish the form and size of all the principal structural elements including the foundations. (20 marks)

d. Prepare general arrangement 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 for the safe construction of the works and an outline programme. (10 marks)





NOTE: All dimensions are in metres

FIGURE Q7

Question 7. Offshore wind farm substructure

Client's requirements

1. A 57.0m-high steel substructure to support a wind turbine generator unit at an elevation of 80.0m above mean sea level at an offshore site with a mean water depth of 35.0m. See Figure Q7. The wind farm will consist of 70 individual units.

Imposed loading

2. Weight of turbine generator unit: 3,000kN (3.0MN).
   Unfactored wind load on turbine and blades 2,200kN (omni-directional) (2.2MN).
   The wave loading profile is as shown in Figure Q7, where D is the diameter in metres of each tubular member in the wave zone.
   Loads are unfactored.

Site conditions

3. Ground conditions:

Sea bed level – 2.0m	Loose sand, N=5
Below 2.0m	Stiff to very stiff clay, C=320kN/m^2

Omit from consideration

4. Design of turbine generator unit.

SECTION 1 (50 marks)

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

b. After submission of your design report, the client requests that a concrete gravity-based substructure option be considered. Write a letter to the client explaining the effect that this option would have on the design and installation of the substructure. (10 marks)

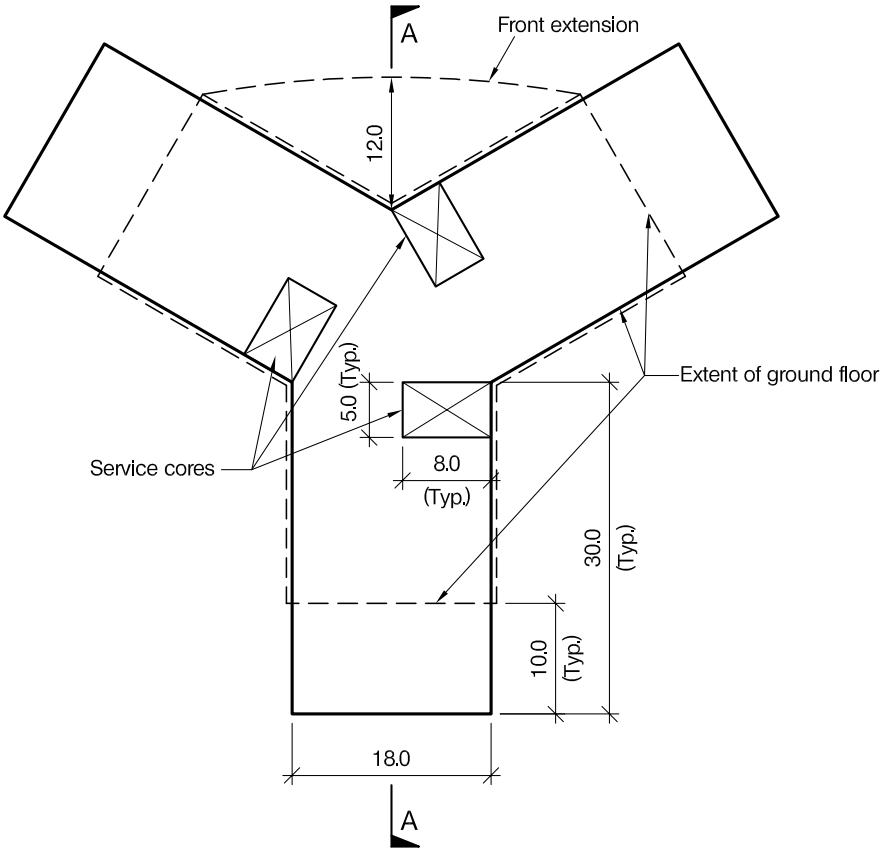
SECTION 2 (50 marks)

For the solution recommended in Section 1(a):

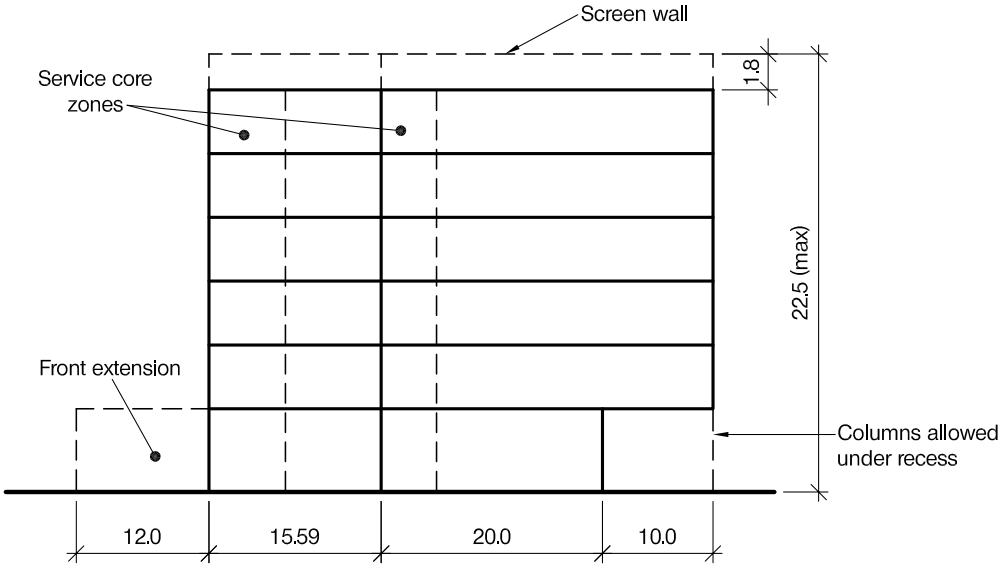
c. Prepare sufficient design calculations to establish the form and size of all principal structural elements including the foundations. (20 marks)

d. Prepare general arrangement 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 and illustrated method statement to describe the installation procedure for the substructure, turbine unit and blades. (10 marks)



TYPICAL PLAN



SECTION A - A

NOTE: All dimensions are in metres

FIGURE Q8-1

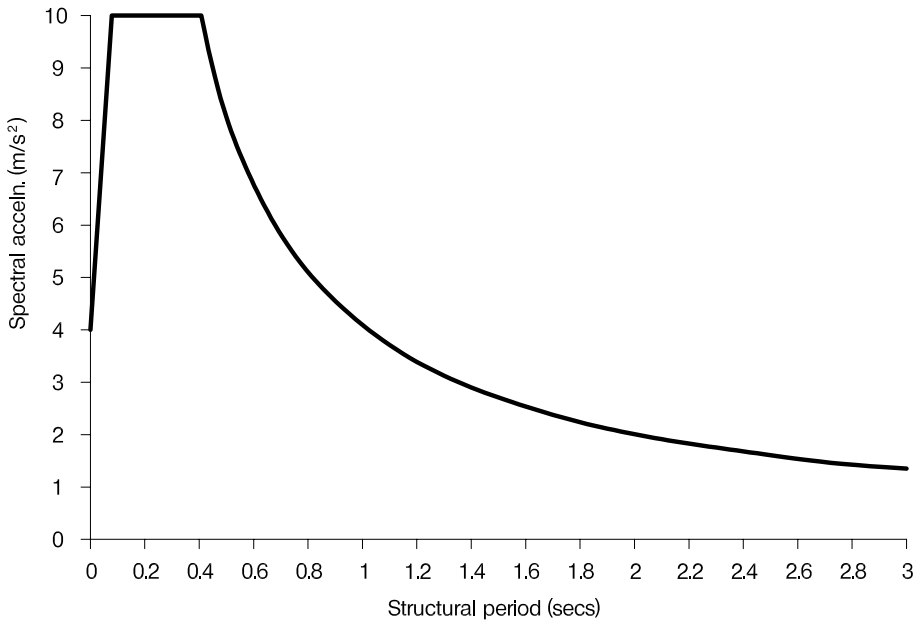


FIGURE Q8-2 : 475 year return period motions for rock outcrop at site

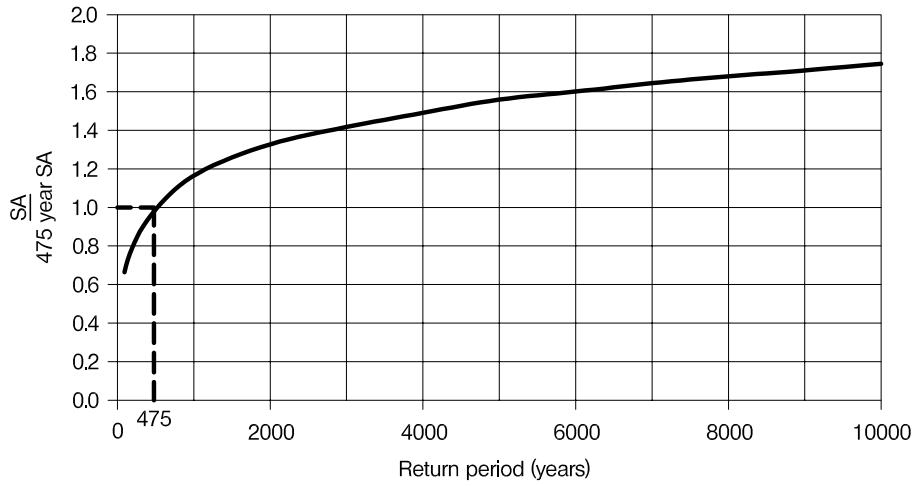


FIGURE Q8-3 : Variation of spectral acceleration SA with return period

NOTE: All dimensions are in metres

FIGURE Q8-2 & FIGURE Q8-3

Question 8. Multi-storey hotel

Client's requirements

1. A six storey hotel in an area of high seismicity. The hotel has three identical rectangular wings and a triangular core area. See Figure Q8-1.
2. The plan at level one is recessed at the outer ends of all three wings and has a single-storey extension at the main entrance. The extent of the level one plan is shown dotted in Figure Q8-1. One pair of columns is permitted at the outer end of each wing. Spacing between level one columns must be at least 15.0m.
3. Clear floor-ceiling heights are to be 2.85m on level one and 2.45m on upper floors. A 1.8m-high screen wall is required around the roof perimeter. The overall height of the building, including the screen wall, must not exceed 22.5m.
4. The building is to be clad above level two with perforated aluminium shutters to provide solar shading. Perimeter columns are to be at minimum spacings of 6.0m. As much as possible of the level one façade is to be glazed.
5. A minimum fire resistance period of two hours is required for structural elements.

Imposed loading

6.

Bedrooms	2.0kN/m^2 and 1.0kN/m^2 for partitions
Level one facilities	5.0kN/m^2
Roof	4.0kN/m2 (includes plant loading)
Corridors/stairs	4.0kN/m^2

Site conditions

7. The site is level, near the outskirts of a large city and near the sea. Basic wind speed is 50.0m/s based on a 3-second gust; the equivalent mean hourly wind speed is 25.0m/s.
8. Ground conditions:

Ground level – 1.0m	Made ground
1.0m – 5.0m	Medium dense sand, N=20
5.0m – 8.0m	Very dense sand & gravel, N=50
Below 8.0m	Rock, allowable bearing pressure 1500kN/m^2

   Ground water was encountered at 5.0m below ground level.
9. Figure Q8-2 shows the design 5% damped seismic response spectrum for the region. It applies to level ground for a 475 year return period, assuming the ground surface is rock with a shear wave velocity of not less than 800m/s.

Omit from consideration

10. Detailed design of stairs, lifts/elevators and façade cladding.

SECTION 1 (50 marks)

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

b. After completion of scheme design, the client asks if a service core can be removed to increase the available space on level one and add extra bedrooms on upper levels. Write a letter to the client advising the structural implications of this change, describing ways to accommodate it. (10 marks)

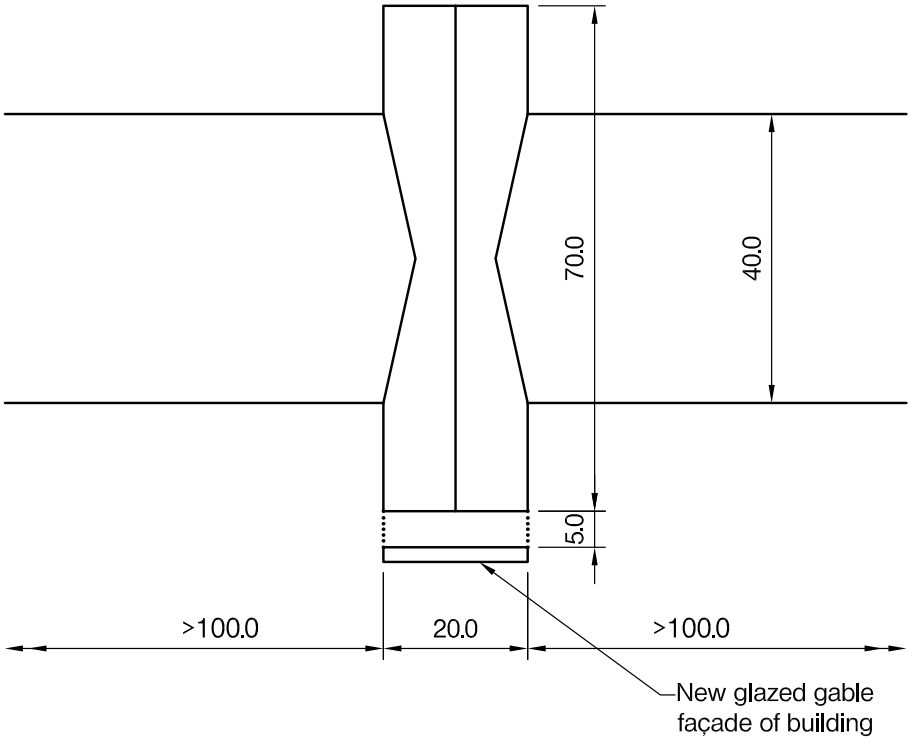
SECTION 2 (50 marks)

For the solution recommended in Section 1(a):

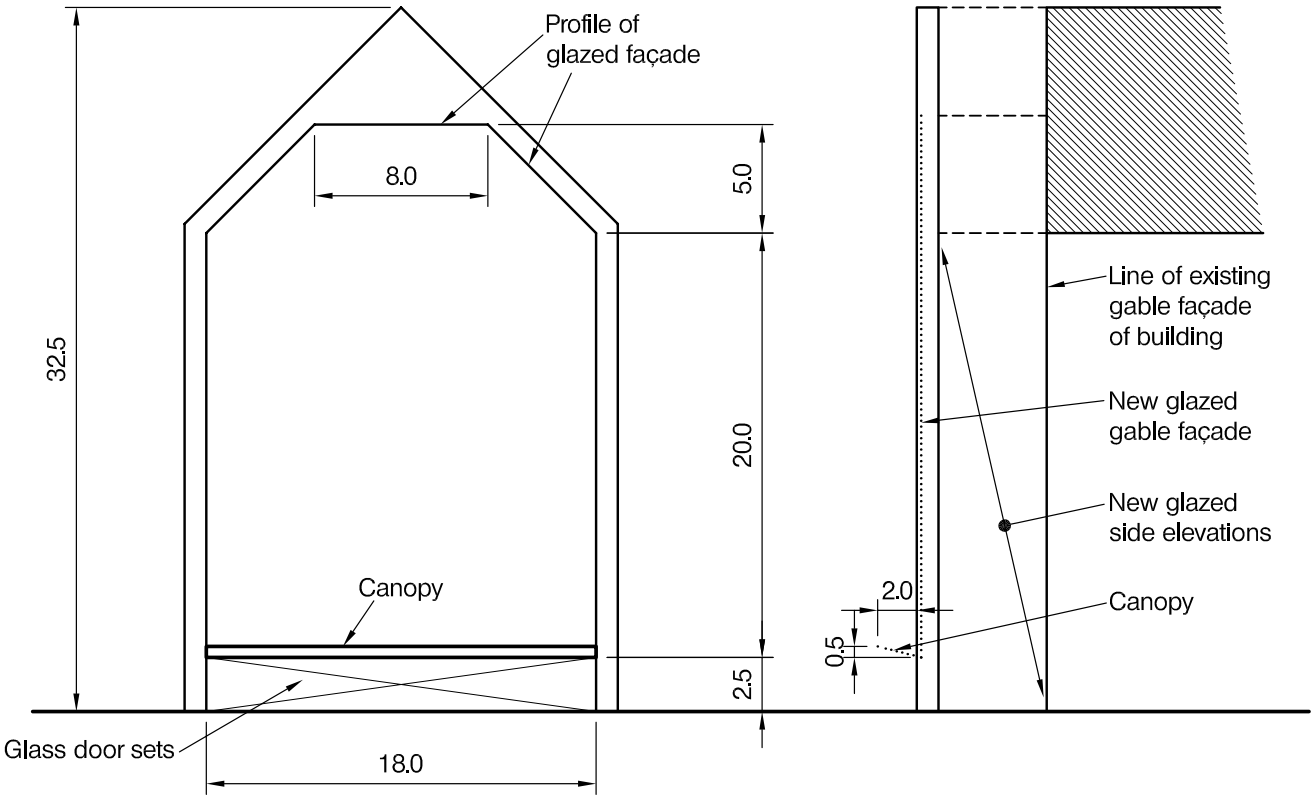
c. Prepare sufficient design calculations to establish the form and size of all the principal structural elements including the foundations. (20 marks)

d. Prepare general arrangement 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 for the safe construction of the building and an outline construction programme. (10 marks)



PLAN OF BUILDING



ELEVATION OF GLAZED FAÇADE

SECTION THROUGH FAÇADE

NOTE: All dimensions are in metres

FIGURE Q9

Question 9. Glass façade and canopy

Client's requirements

1. A new glass façade for a shopping centre, replacing an existing gable façade and incorporating a glass canopy. See Figure Q9.
2. The façade will comprise cavity glass units 30.5mm thick. The canopy glass is to be toughened laminated glass panes 18.5mm thick. Glass elements must not exceed 1.5m x 2.0m in size.
3. Glass units and panes may be supported by partial or complete framing, or be point fixed. Mounting must allow any unit to be removed independently for maintenance. The support system is expected to enhance the visual aspect of the gable. Except for the canopy, the support system must be entirely on the inside face of the glass.
4. The supporting structure for the façade is 5.0m from the existing gable wall and must match its profile. The new structure must resist all in-plane forces. Forces normal to the new façade may be transmitted to the existing building.
5. No structure is permitted in the opening for the door sets.

Imposed loading

6. Imposed load on canopy 0.6 kN/m^2
   Imposed load on roof 0.3 kN/m^2
   A maintenance point load of 0.5kN applied horizontally normal to the façade anywhere on the support system.

Site conditions

7. The site is located on the edge of a town, close to open countryside. Basic wind speed is 46.0m/s based on a 3-second gust; the equivalent mean hourly wind speed is 23.0m/s.
8. Ground conditions:

Ground level – 2.0m	Made ground
2.0m – 8.0m	Sand and gravel, N=30
Below 8.0m	Sandstone, allowable bearing pressure 1000kN/m^2

Omit from consideration

9. Design of the glass door sets. Detailed design of the glass units and panes. Roof support structure. Cladding to the gable frame.

SECTION 1 (50 marks)

a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable solutions for the proposed structure for the gable and supporting the facades, including the method of support to the glass and accommodation of structural movement. Indicate clearly the functional framing, load transfer and stability aspects of each scheme. Identify the solution you recommend, giving reasons for your choice. (40 marks)

b. After your design is complete, the client advises that trial holes at the site of the new gable show that the made ground is 6.0m deep. Write a letter to the client advising the structural implications and the effect of this on your design. (10 marks)

SECTION 2 (50 marks)

For the solution recommended in Section 1(a):

c. Prepare sufficient design calculations to establish the form and size of all the principal structural elements including the support system for the glass. (20 marks)

d. Prepare general arrangement 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 for the demolition of the existing gable and the safe construction of the façade, and an outline construction programme. (10 marks)

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