The Institution of Structural Engineers

Membership Examination Part 3

17 APRIL 1998

Structural Engineering Design and Practice

9.30 a.m. - 1 p.m. and 1.30 - 5 p.m. (Discussion between individuals is not permitted during the luncheon 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 books, 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 drawings must bear the candidate's index number and the question number in the bottom right-hand corner. Only the answer book(s) 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. 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.
3. In all questions 40 marks are allocated to Part 1 and 60 marks to Part 2.
4. 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.
   Candidates should read carefully the examiners' reminder on Page 3.
5. Any assumptions made and the design data and criteria adopted must be stated.
6. Portable battery calculators may be used but sufficient calculations must be submitted to substantiate the design, and these should be set out as in practice.
7. Good clear drawings and sketches are required; they should show all salient and structural features to suitable scales and should incorporate adequate details.
8. This paper is set in SI Units, together with an alternative set of numerical data in British Imperial Units in parentheses. Candidates may use either set of data and may work in either system of units but should note that the two sets of data do not necessarily correspond. This is in order to avoid complicated arithmetic in one set of units.

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 is 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.

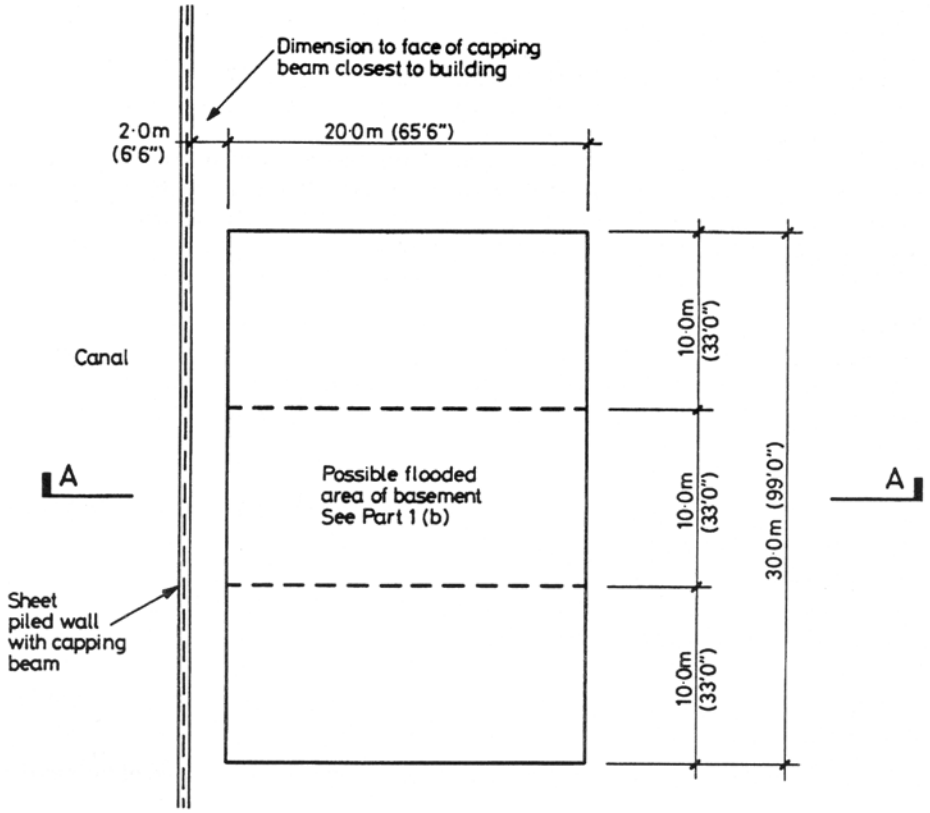
The unusual requirement of the examination is that you must demonstrate the validity of the training and experience that you have acquired in recent years. The Institution must be satisfied that you are able to bring all the various skills you are expected to possess to the effective solution of structural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

A Chartered Structural Engineer must have an ability to design and a facility to communicate his 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 understand the general structural engineering design principles involved.

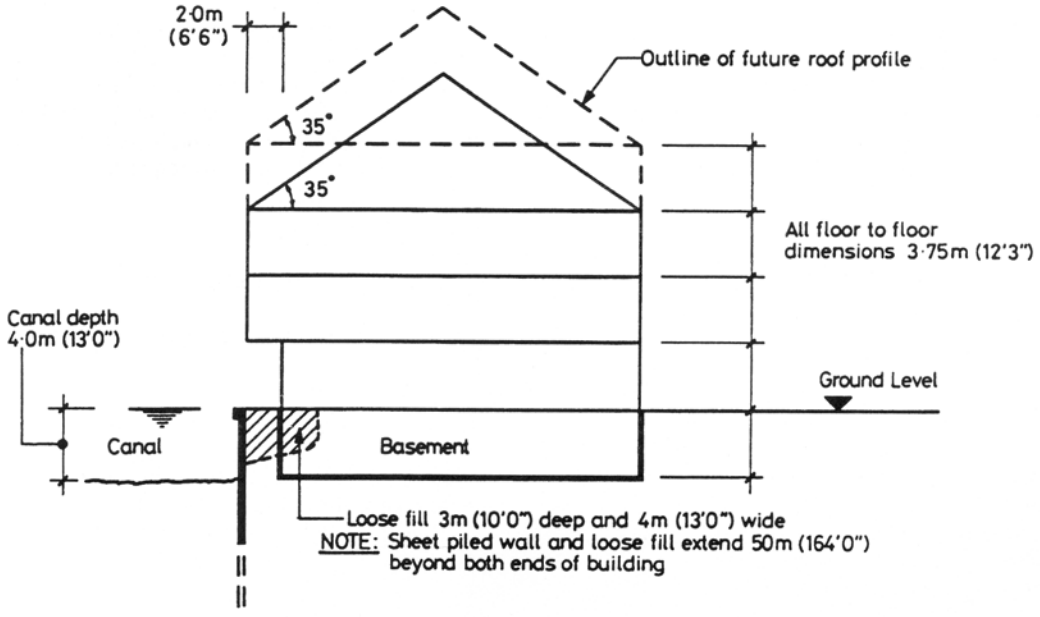
In selecting and developing your design you should also remember the guidance given in the Institution's report, 'Aims of Structural Design', and in particular:

(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 5, 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.



PLAN AT GROUND FLOOR LEVEL



SECTION A-A

NOTE All dimensions are in metres (feet and inches)

FIGURE Q1

Question 1
Waterside Office

Client's requirements

1. A three-storey office with a basement and a pitched tiled roof; see Figure Q1.
2. The building is situated 2m (6'-6") from the edge of an existing canal. At the first and the second floor level, the building line is to be vertically above the edge of the canal.
3. The building is to have provision for the later addition of a further storey with a pitched tiled roof.
4. Elevations are to be brick clad and bracing is not permitted in external elevations.
5. The client requires a minimum internal column spacing of 6m (20'-0") between centres, with no internal column centre being closer than 6m (20'-0") to an external wall.
6. Floor to floor levels are 3.75m (12'-3") and the maximum construction depth for all floor levels is 0.6m (2'-0").
7. Canal bank improvement works have already been carried out. The embankment has a sheet piled wall with a concrete capping beam.

Imposed loadings

8.

Roof	$0.75kN/m^2$	$(15lbf/ft^2)$
Office floors	$5.0kN/m^2$	$(100\ lbf/ft^2)$

Site conditions

9. The site is situated on the outskirts of a large town.
   Basic wind speed is 40m/s (90 mile/h) based on a 3 second gust; the equivalent mean hourly wind speed is 20 m/s (45 mile/h).
   Note: The 3 second gust speed is used in the British Standard CP3 and the mean hourly wind speed is used in the British Standard 6399. Candidates using other codes and standards should choose an appropriate wind speed.
10. Ground conditions:

Ground level - 1.0m (3'-3")	Topsoil and loose fill
Below 1.0m (3'-3")	Chalk (N=25)

   There is a 4m (13'-0") wide, 3m (10'-0") deep zone of loose fill adjacent to the edge of the canal as shown in Figure Q1.

Omit from consideration -

11. Design of staircases, lift shafts and any canal works.

PART 1 (40 marks)

a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable structural solutions for the building, foundations, floors and basement. Indicate clearly the functional framing, the load transfer and stability aspects of each scheme. Identify the solution you recommend, giving reasons for your choice.

b. After your recommended solution has been approved in principle, the client asks that a 10m (33'-0") width of the basement should be flooded to house a boat. The ground floor over this area would be removed. Write a letter to the client explaining how your design would have to be altered to meet this request.

PART 2 (60 marks)

For the solution recommended in Part 1(a):

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

d. Prepare general arrangement plans, sections and elevations to show the dimensions, layout and disposition of the structural elements for estimating purposes.

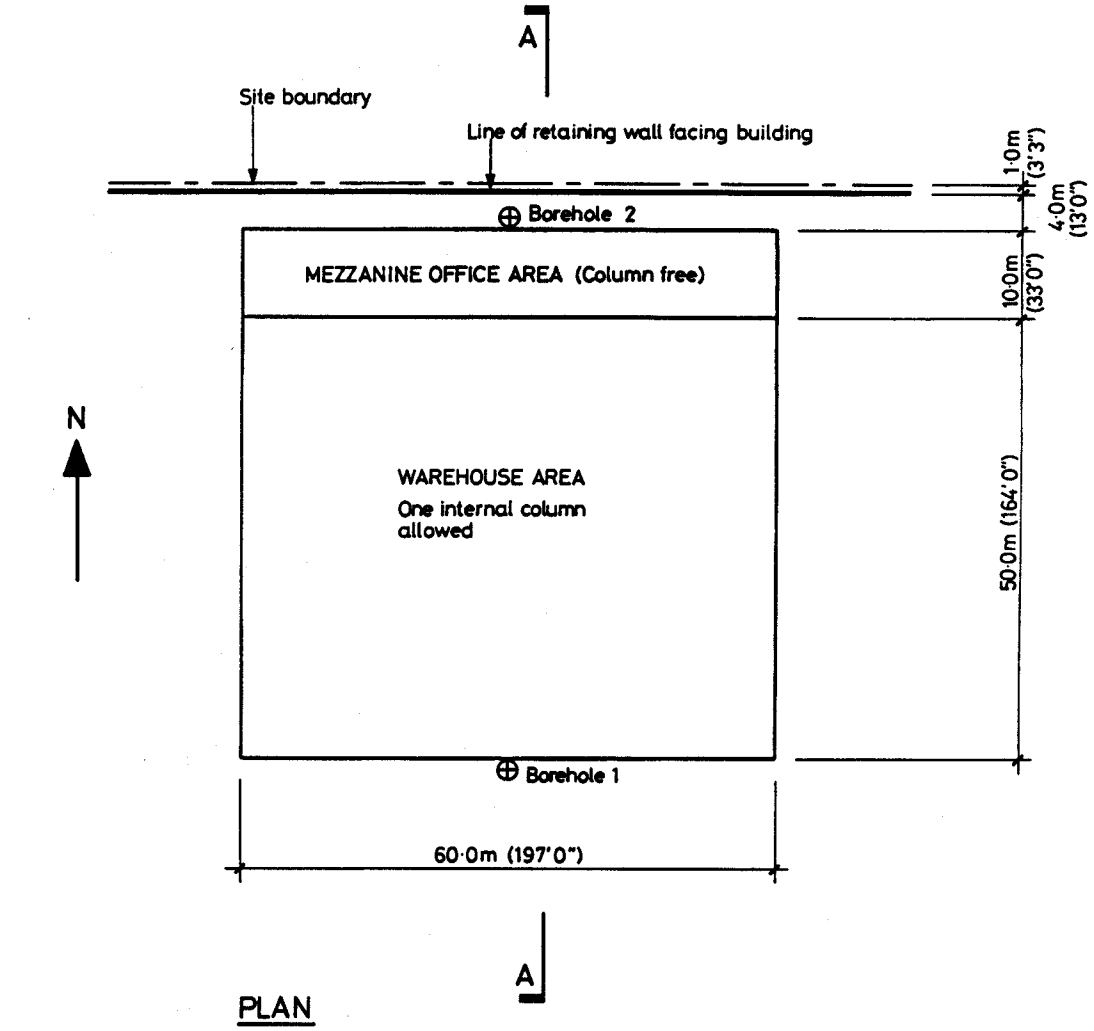
e. Prepare clearly annotated sketches to illustrate details of:

(i) The connection between the first floor cantilever beam on the canal side of the building and a supporting column.

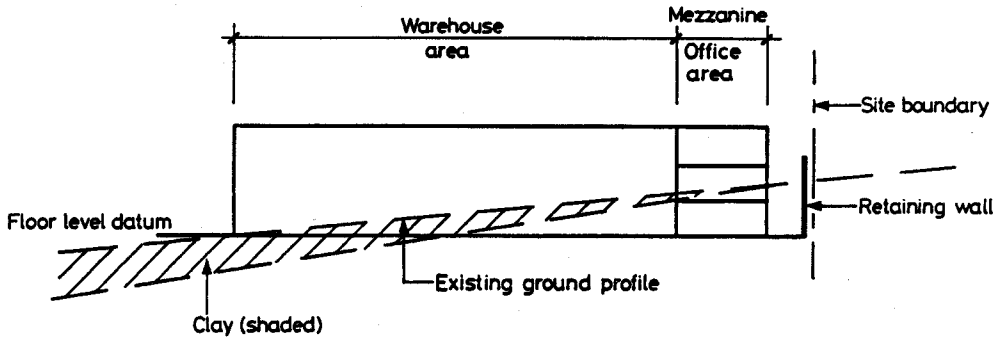
(ii) The connection between the pitched roof and its support.

(iii) The basement wall and foundation showing any provision for watertight construction.

f. Prepare a detailed method statement for the safe erection of the building taking into account the constraints imposed by the canal.



PLAN



SECTION A–A AND GEOLOGICAL PROFILE

(Topsoil omitted for clarity)

NOTE All dimensions are in metres (feet and inches)

FIGURE Q2

Question 2
Retail Distribution Centre

Client's requirements

1. A retail distribution centre with a ground floor and 2 internal mezzanine floors for offices; see Figure Q2.
2. The clear internal height of the building throughout the warehouse area is 10.0m (33'-0"). The overall height of the whole building, which has a flat roof, must not exceed 12.5m (41'-0"). The roof must be at a constant level throughout except for minor variations for drainage.
3. The mezzanine office floor to floor level is to be 4.0m (13'-0"). The headroom at ground, first and second floors within the mezzanine is 3.25m (10"-6").
4. All elevations and the roof are to be clad with profiled metal sheeting.
5. There are no restrictions in column spacing on external elevations or at the junction of the mezzanine and warehouse. No columns are permitted within the mezzanine areas. One column is permitted within the warehouse area.
6. The existing ground slopes across the site. At the Southern end the ground floor will be at existing ground level. At the Northern end the ground floor will be 6m (20'-0") below existing ground level. The cross section and soil profile is constant across the site in an East-West direction.
7. A retaining wall will be required along the Northern boundary of the site. The exposed face of the wall is to be 4m (13'-0") away from the building. The site boundary is 5m (16'-3") away from the building; no construction operations will be allowed beyond this boundary.

Imposed loadings

8.	Roof (imposed + services+ self weight of roof covering)	1.2kN/m^2	(24 lbf/ft^2)
	Mezzanine	5kN/m^2	(100lbf/ft^2)
	Ground floor	50kN/m^2	(1000 lbf/ft^2)

Site conditions

9. The site is situated in open countryside.
   Basic wind speed is 40m/s (90 mile/h) based on a 3 second gust; the equivalent mean hourly wind speed is 20 m/s (45 mile/h).
   Note: The 3 second gust speed is used in the British Standard CP3 and the mean hourly wind speed is used in the British Standard 6399. Candidates using other codes and standards should choose an appropriate wind speed.
10. Ground conditions:
    The ground conditions vary across the site as shown in Section A-A, Figure Q2.
    Borehole 1 (Existing ground level is at proposed ground floor level).

Ground level - 0.3m (1'-0")	Topsoil	
0.3m (1'-0") - 4.0m (13'-0")	Clay	C = 100kN/m^2 (2000 lbf/ft^2)
Below 4.0m (13'-0")	Chalk	(N = 25)

    Borehole 2 (Existing ground level is 6m (20'-0") above proposed ground floor level)

Ground level - 0.3m (1'-0")	Topsoil	
Below 0.3m (1'-0")	Chalk	(N = 25)

    The chalk and clay surfaces form a straight line between recorded levels in the boreholes.
    Groundwater was not encountered.

Omit from consideration

11. Detailed design of retaining wall, staircases, lift shafts and roof covering.

PART 1 (40 marks)

a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable structural solutions for the building, foundations and floors. Indicate clearly the functional framing, the load transfer and stability aspects of each scheme. Identify the solution you recommend, including the type of retaining wall, giving reasons for your choice.

b. After your recommended solution has been approved in principle, the client asks that the single column in the warehouse is removed. Write a letter to the client explaining the effect of this request on the design and construction programme.

PART 2 (60 marks)

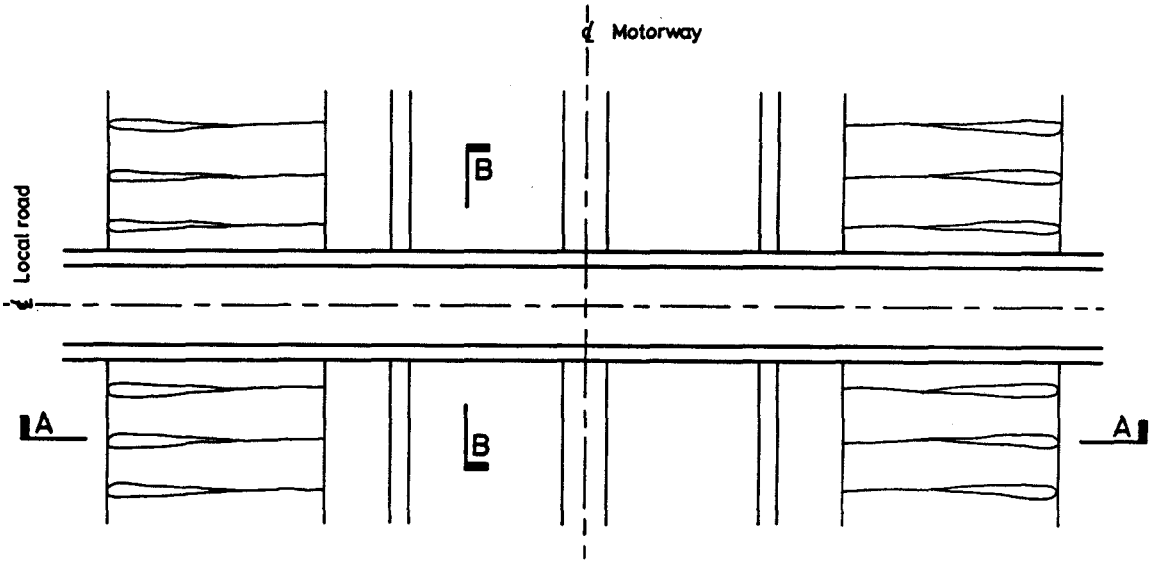
For the solution recommended in Part 1(a):

c. Prepare sufficient design calculations to establish the form and size of all principal structural elements including the foundations and the ground floor slab.

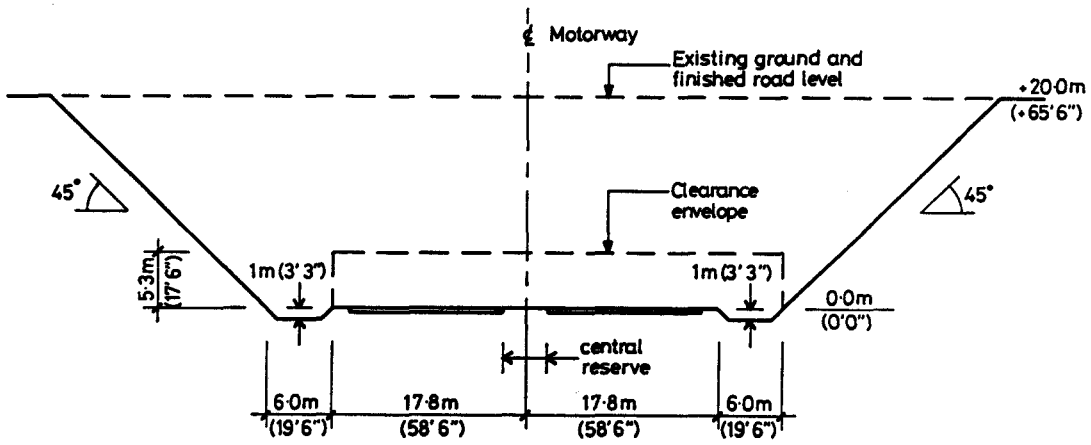
d. Prepare general arrangement plans, sections and elevations to show the dimensions, layout and disposition of the structural elements for estimating purposes.

e. Prepare clearly annotated sketches to illustrate details of:
   (i) The retaining wall along the Northern site boundary.
   (ii) The junction of the internal warehouse column and the roof.
   (iii) A column between the mezzanine and warehouse showing the connection to the warehouse roof and the office roof.

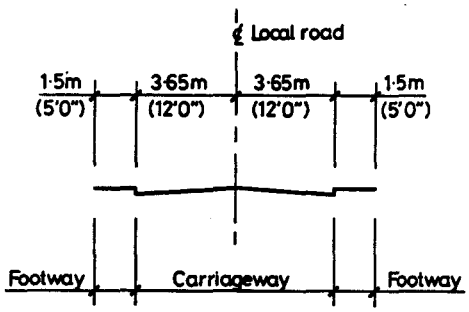
f. Prepare a detailed method statement for the safe construction of the retaining wall along the Northern site boundary.



PLAN



SECTION A-A



SECTION B-B

NOTE All dimensions and levels are in metres (feet and inches)

FIGURE Q3

Question 3
Motorway Overbridge

Client's requirements

l. A bridge is required as part of a road scheme to carry an existing local road over a new section of dual three lane motorway which is to be constructed as part of the same contract as the bridge; see Figure Q3.

2. At the location of the bridge, the motorway is situated in a chalk cutting. The appearance of the bridge is, therefore, an important design consideration.

3. In pursuance of an aesthetically pleasing design, no supports are permitted within the central reserve of the motorway.

4. A vehicle/pedestrian parapet shall be provided adjacent to each footway on the bridge.

5. The existing local road will be closed during construction of the motorway and the bridge.

Imposed loadings

6. Vertical traffic loading shall comprise a uniformly distributed load of 10kN/m^2 (200 lb/ft^2), with an alternative load for local effects of 100kN (10 tonf) on a 0.3m (1'-0") by 0.3m (1'-0") contact area.

7. Vertical footway loading shall comprise a uniformly distributed load of 4kN/m^2 (80 lb/ft^2).

8. Design temperature range is 50°C.

Site conditions

9. At the site of the bridge, the chalk has a typical compressive strength of 4MN/m^2 (37 tonf/ft^2).

Omit from consideration

10. Design of the chalk cutting, vehicle pedestrian/parapet and detailed consideration of wind loading.

PART 1: (40 marks)

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

b. After your recommended solution has been approved in principle, a review is undertaken of the chalk cutting design and, as a result, the client asks for the slope angle to be increased from 45° to 60°. Write a letter to the client explaining the implications of this change on the design of the bridge, including economy of construction and appearance.

PART 2 (60 marks)

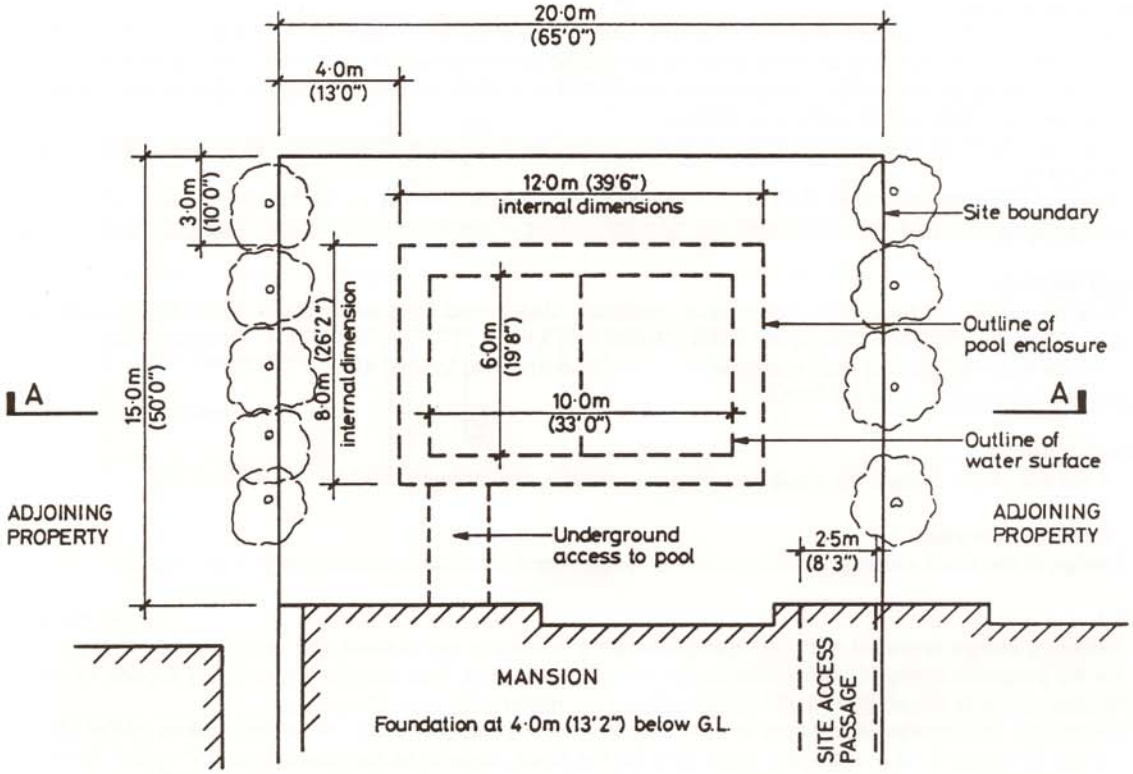
For the solution recommended in Part 1(a):

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

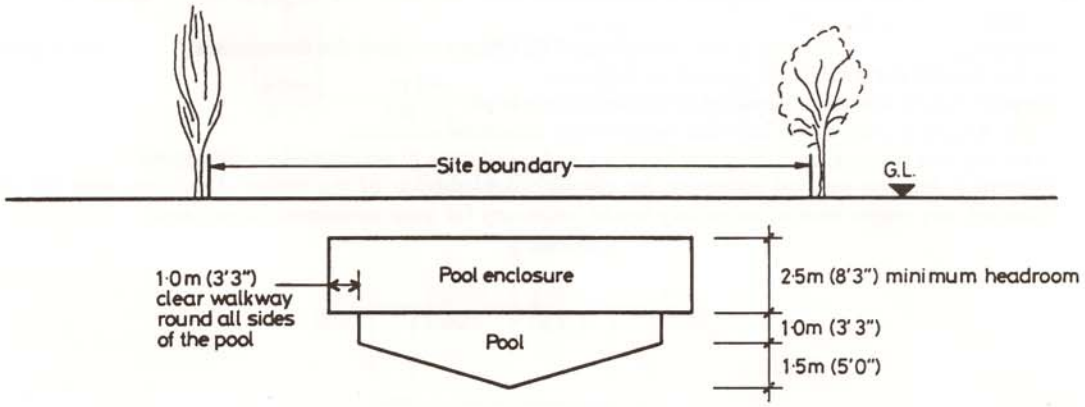
d. Prepare general arrangement plans, sections and elevations to show the dimensions, layout and disposition of the structural elements for estimating purposes.

e. Prepare clearly annotated sketches to illustrate details of.
   (i) A typical connection between two primary structural elements.
   (ii) An end support, including any bearings and provisions to accommodate movement.

f. Prepare a detailed method statement for the safe construction of the bridge. Describe, with the aid of sketches, any major item of temporary works necessary for your recommended solution.



PLAN



SECTION A – A

NOTE All dimensions are in metres (feet and inches)

FIGURE Q4

Question 4
Underground Swimming Pool

Client's requirements

1. An underground swimming pool beneath the garden of a residential mansion; see Figure Q4.
2. To comply with planning and environmental constraints, all parts of the structure are to be buried and invisible from above, and noise during construction is to be kept to a minimum.
3. The garden is 20m (65'-0") wide and 15m (50'-0") long. The only access to the site is via a narrow enclosed passageway at the side of the mansion. The passageway is 2.5m (8'-3") wide and has 2.0m (6'-6") clear headroom.
4. The pool is to be rectangular in plan with a water depth of 1.0m (3'-3") at each end and 2.5m (8'-3") at the centre. Landscaping requires a minimum depth of topsoil over the structure of 0.5m (1'-8"). The pool will be reached from the mansion via an underground access way.
5. A clear walkway of minimum width 1.0m (3'-3") is required around all four sides of the pool. The water surface is to be level with the walkway, and the minimum headroom over the walkway and the pool is to be 2.5m (8'-3").
6. No internal supports are permitted anywhere within the pool enclosure.

Imposed loadings

7. Over the area of the garden: 1 0kN/m^2 (200 lbf/ft^2).

Site conditions

8. A level site in a suburb on the outskirts of a large city.
9. Ground conditions

Ground level - 0.3m (1'-0")	Topsoil
0.3m (1'-0") - 2.0m (6'-6")	Sand and Gravel (N = 5)
Below 2m (6'-6")	Clay. Average C = 50kN/m^2 (1000 lbf/ft^2)

Ground water was encountered at 1.0m (3'-3") below ground level.
A site investigation has indicated that the foundations of the existing buildings are unlikely to be adversely affected by the proposed construction.

Omit from consideration

10. The underground access way to the mansion, and of services within the pool enclosure.

PART 1 (40 marks)

a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable structural 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.
b. After receiving your completed design, the client asks whether the width of the pool can be increased from 6.0m (19'-8") to 9.0m (29'-6"). Write a letter to the client outlining the implications of this proposed change on the design, construction and cost of the scheme.

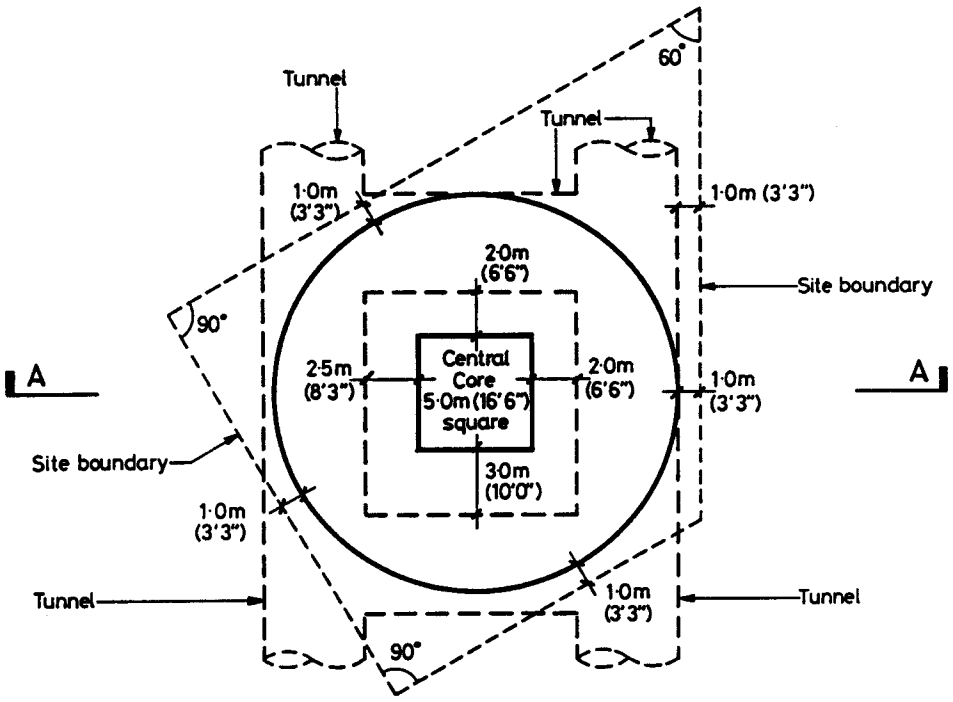
PART 2 (60 marks)

For the solution recommended in Part 1(a):

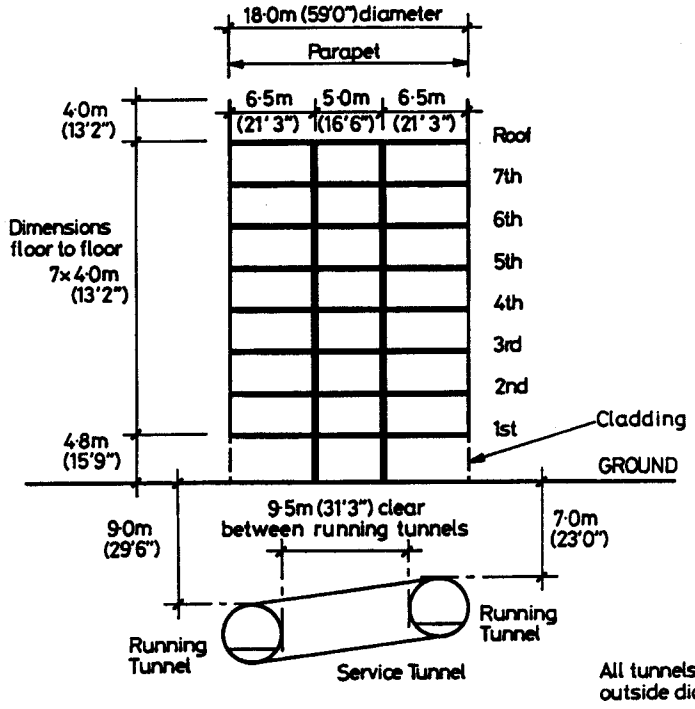
c. Prepare sufficient design calculations to establish the form and size of all principal structural elements including the foundations.
d. Prepare general arrangement plans, sections and elevations to show the dimensions, layout and disposition of the structural elements for estimating purposes.

e. Prepare clearly annotated sketches to illustrate details of.
   (i) The junction between the walls and the roof of the pool enclosure.
   (ii) The junction between the base of the pool and the pool walls including any provision for watertight construction.

f. Prepare a detailed method statement for the safe construction of the structure, identifying any temporary works that are necessary.



PLAN



SECTIONAL ELEVATION A-A

NOTES All dimensions are in metres (feet and inches)
Plan and Sectional Elevation A-A are drawn to different scales

FIGURE Q5

Question 5
City Centre Headquarters Building

Client's requirements

1. A new 8-storey building is to be constructed on a site next to a major city-centre transport interchange, as the local headquarters for an international air-travel organisation; see Figure Q5.
2. The building is circular in plan and occupies almost the whole of the site. No part of the structure may extend beyond the site boundary. Fully-glazed cladding is required from ground level to roof level on all sides of the building. Vertical structural elements and ceiling soffits are to be left exposed.
3. A central core containing stairs and lifts is to be incorporated into the new structure. No other vertical structural elements, except for cladding support framing, are permitted anywhere between ground and first floor.
4. Floor-to-floor dimensions are shown in Figure Q5. A minimum clear floor-to-ceiling height of 3.0m (10'-0") must be provided at every level throughout the structure.
5. The roof is to be used as a platform for mechanical and electrical services equipment. The roof is surrounded by cladding forming a parapet 4.0m (13'-2") high.
6. The fire resistance of the new structure is to be 2 hours.

Imposed loadings

7.	Roof	7.5kN/m^2	(150 lbf/ft^2)
	Floors	4.0kN/m^2	(80 lbf/ft^2)

Site conditions

8. A level site in a city centre.
   Basic wind speed is 40m/s (90 mile/h) based on a 3 second gust; the equivalent mean hourly wind speed is 20 m/s (45 mile/h).
   Note: The 3 second gust speed is used in the British Standard CP3 and the mean hourly wind speed is used in the British Standard 6399. Candidates using other codes and standards should choose an appropriate wind speed.
9. Ground conditions
   Ground level - 3.0m (10'-0") Made ground (clay and rubble)
   Below 3.0m (10'-0") . Stiff Clay C = 250kN/m^2 (5000 lbf/ft^2)
   Groundwater was not present.
10. Running tunnels and service tunnels for an existing underground railway pass under the site. The new building must not impose any additional significant loading on these tunnels. No part of the new structure may be closer than 1.0m (3'-3") to any part of the tunnels.

Omit from consideration

11. Detailed design of cladding system and services.

PART 1 (40 marks)

a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable structural 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.

b. At a presentation of the proposed scheme, the client approves the form and appearance of the building and wishes to adopt it as the model for similar local headquarters buildings in other countries. One of the proposed locations is in an earthquake zone. Write a letter to the client explaining the effect that this will have on the design, construction and cost of the building.

PART 2 (60 marks)

For the solution recommended in Part 1(a):

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

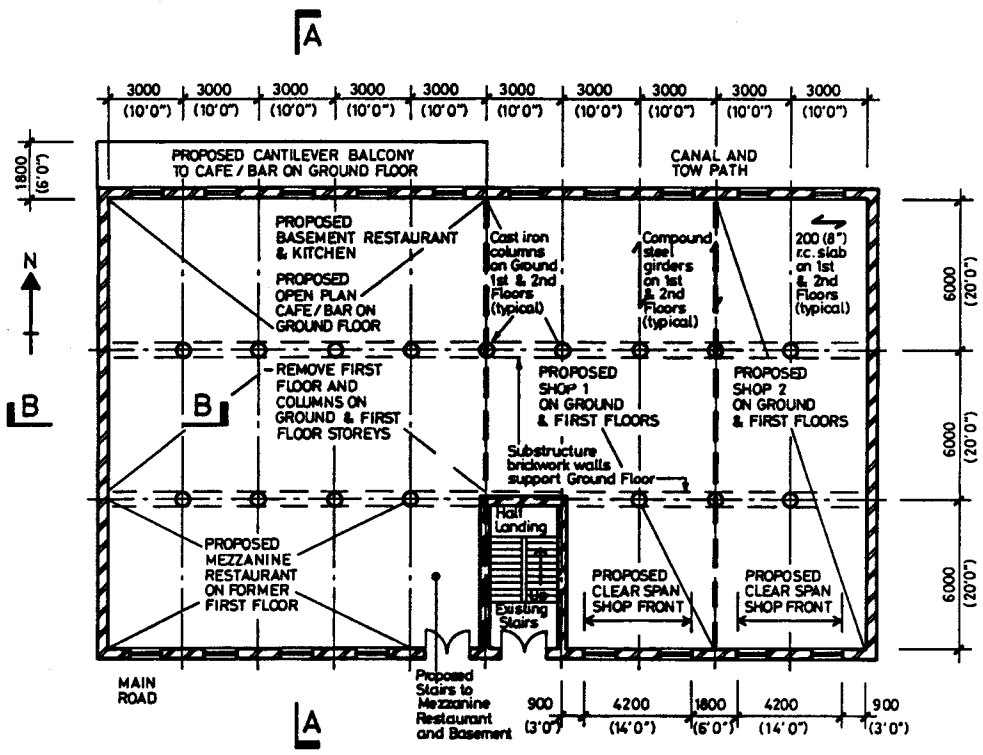
d. Prepare general arrangement plans, sections and elevations to show the dimensions, layout and disposition of the structural elements for estimating purposes.

e. Prepare clearly annotated sketches to illustrate details of

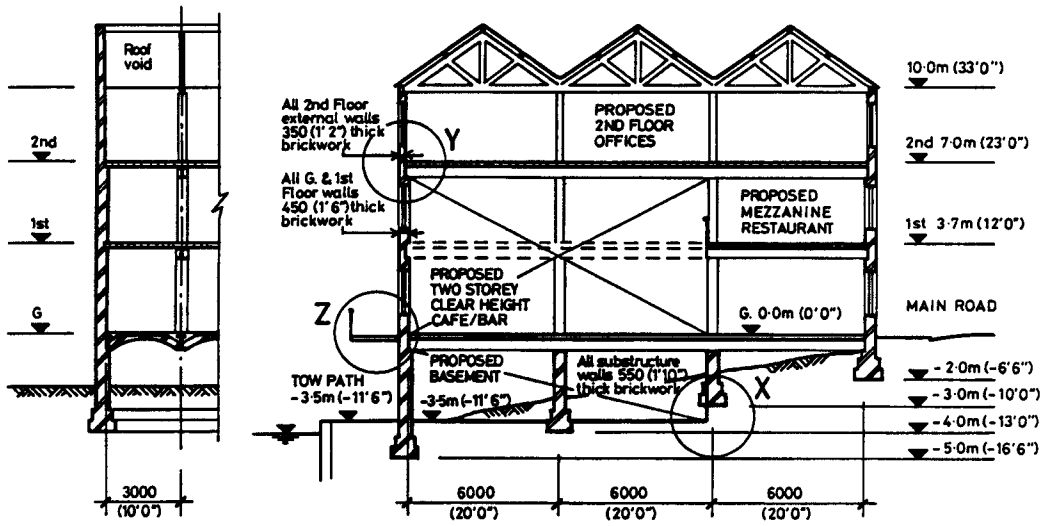
(i) The junction between the base of the central core and the foundations.

(ii) The roof structure and waterproofing, including the method of supporting mechanical plant on the roof.

f. Prepare a detailed method statement for the safe construction of the foundations, identifying any investigative work and temporary works necessary.

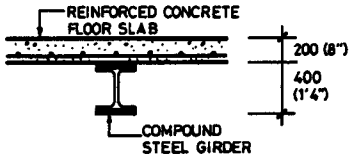


GROUND FLOOR PLAN



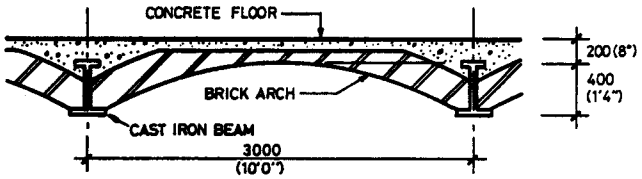
SECTION B-B

SECTION A-A



TYPICAL SECTION THROUGH 1ST & 2ND FLOOR / BEAMS

SAFE WORKING LOAD CAPACITY 5 kN/m² (100lb/ft²)



TYPICAL SECTION THROUGH JACK ARCH GROUND FLOOR

SAFE WORKING LOAD CAPACITY 6kN/m² (120 lb/ft²)

NOTE All levels are in metres (feet and inches)
All other dimensions are in millimetres (feet and inches)

FIGURE Q6

Question 6
Refurbishment of Mill for Cafe/Bar, Shops and Offices

Client's requirements

1. A former and now derelict textile mill is to be refurbished for a cafe/bar, shops and offices. It is situated between a main road and a canal in the centre of a town. The site slopes down by about a storey height from the main road at the front to the canal at the rear; see Figure Q6.
2. The existing mill building has brickwork external walls and, cast iron internal columns. These support a brick arch/cast iron beam ground floor and two upper floors of reinforced concrete slabs spanning on to compound steel girders. The roof covering is of slate and it is supported by timber rafters and purlins, which span on to timber trusses.
3. The cafe/bar is to have a full height, two-storey area, created from part of the ground and first floors in the western half. It is to have a mezzanine restaurant area created from the remaining first floor area in the western half. Two shops are to occupy the remainder of the ground and first floors. An office suite is to be created from the second floor, accessed from an existing stairwell. Two clear span shop windows are to be created on the main road elevation by the removal of external wall piers on the ground floor.
4. The café/bar is to have a basement restaurant and kitchen, created from the undercroft under the western half. The basement is to have a net plan area of 180m^2. Access to the mezzanine restaurant and basement is to be from a new stairwell.
5. There is to be a cantilevered balcony extension for the cafe/bar along the western half of the canal elevation.
6. One hour minimum fire resistance is required for all structural elements.

Imposed loadings

7.	Roof	0.75kN/m^2	(15 lbf/ft^2)
	Offices and shops	4.0kN/m^2	(80 lbf/ft^2)
	Cafe/bar	5.0kN/m^2	(100 lbf/ft^2)
	Restaurant	4.0kN/m^2	(80 lbf/ft^2)
	Kitchen	4.0kN/m^2	(80 lbf/ft^2)

Site conditions

8. The site is located in a town centre. Basic wind speed is 40m/s (90 mile/h) based on a 3 second gust; the equivalent mean hourly wind speed is 20 m/s (45 mile/h).
   Note: The 3 second gust speed is used in the British Standard CP3 and the mean hourly wind speed is used in the British Standard 6399. Candidates using other codes and standards should choose an appropriate wind speed.
9. Ground conditions established from trial pits (from main road level) are:

Ground level - 1.0m (3'-3")	Made ground with clay, ash, etc.
l .0m (3'-3") - 2.5m (8'-0")	Firm clay: C = 50kN/m^2 (1000 lbf/ft^2)
2.5m (8'-0") - 4.5m (14'-6")	Stiff clay: C = 100kN/m^2 (2000 lbf/ft^2)
Below 4.5m (14'-6")	Mudstone: C = 200kN/m^2 (4000 lbf/ft^2)

   The ground water level is typically at about -4.0m (-13'-0").

Omit from consideration

10. Proof of the load capacity of the existing structure and design of the stairs.
11. Design of replacement for fire damaged roof in Part 2.

PART 1 (40 marks)

a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable structural solutions for the converted mill building. Indicate clearly the functional framing, load transfer and stability aspects of each scheme. Identify the solution you recommend, giving reasons for your choice.

b. After your recommended solution has been approved in principle, a fire occurs throughout the eastern half of the mill. The fire destroys the roof. Explain in a letter to the client what effects this will have on the existing building and the plans for the refurbishment/ alterations. Outline any investigation and potential remedial work that should be implemented.

PART 2 (60 marks)

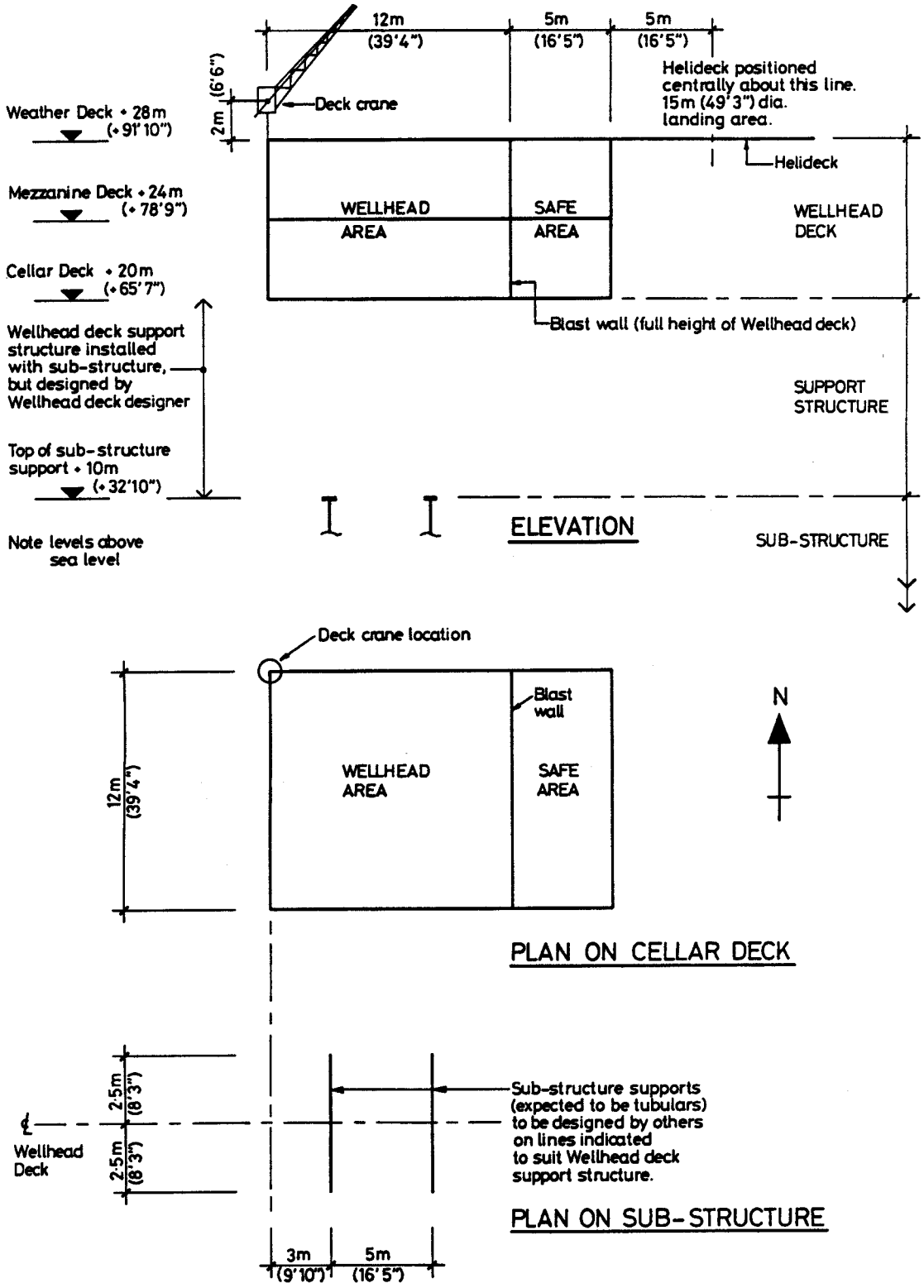
For the solution recommended in Part 1(a):

c. Prepare sufficient design calculations to establish the form and size of all new principal structural elements, including any new foundations.

d. Prepare general arrangement plans, sections and elevations to show the dimensions, layout and disposition of the structural elements for estimating purposes.

e. Prepare clearly annotated sketches to illustrate details of
   (i) Any foundation improvement required for construction of the basement restaurant at X.
   (ii) The connection of any new supporting structure with the existing at Y.
   (iii) The balcony, balustrading and cantilever connection to the existing structure at ground floor level at Z.

f. Prepare a detailed method statement for the safe execution of your recommended alterations to the building, identifying any temporary works that you consider necessary.



NOTE All dimensions and levels are in metres (feet and inches)

FIGURE Q7

Question 7 Wellhead Deck

Client's requirements

1. A wellhead deck comprising weather deck, mezzanine deck, cellular deck and helideck is required to house up to 4 wellheads.
2. A support structure is required from the top of the substructure designed to minimise wave loading up to the underside of the cellar deck.
3. The wellhead area is to be provided with an open grated flooring on mezzanine and cellar decks. The weather deck and safe area deck will be plated.
4. The structure from +10m (+32'-10") level to the underside of the cellar deck will be installed with the substructure. The wellhead deck will then be lifted onto the structure and the crane will be disengaged as quickly as possible.
5. The deck will be clad only around the safe area. The wellhead area will be as open as possible to facilitate dispersion of any gas leaks.
6. The wellhead area is to be open on both cellar and mezzanine decks to maximise space use for equipment.

Loadings requirements

7. Basic wind speed is 40m/s (90 mile/h) based on a 3-second gust; the equivalent mean hourly wind speed is 20 m/s (45 mile/h).
   Note: The 3 second gust speed is used in the British Standard CP3 and the mean hourly wind speed is used in the British Standard 6399. Candidates using other codes should choose an appropriate value.
8. Deck superimposed loading:

Wellhead cellar deck	1 0kN/m^2	(200 lbf/ft^2)
Wellhead mezzanine deck	4N/m^2	(80 lbf/ft^2)
Safe area deck	2.5kN/m^2	(50 lbf/fl^2)
Helideck helicopter	100kN	(10 tonf)

9. Blast loading - from wellhead area blast pressure of 0.4 bar (6.5 lbf/in^2)
10. Wave loading - +10m to +19m (+32'-10" to +62'-4") 50kN/m^2 (1000 lbf/ft^2)
11. Crane capacity 40kN (4 tonf) at max radius 16m (50'-0").

Omit from consideration

12. Design of substructure - other than specifying the required support arrangement.
13. Wellhead/Tree arrangement.
14. Design of deck crane.

PART 1 (40 marks)

a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable structural solutions for the proposed new wellhead deck and support structure above the +10m level. In each case the method of load out and installation should be discussed. Indicate clearly the functional framing, the load transfer and stability aspects of each scheme. Indicate the type of blast wall you recommend. Identify the solution you recommend, giving reasons for your choice.

b. Having received your recommended design the client wishes to increase the blast loading in the wellhead area from 0.4 bar (6.5 lbf/in^2) to 0.8 bar (13.0 lbf/in^2) as a result of receipt of new blast test data. Write a letter to the client outlining the effects this consideration will have on your chosen solution.

PART 2 (60 marks)

For the solution recommended in Part 1(a):

c. Prepare sufficient design calculations to establish the form and size of all principal structural elements for both the temporary and the permanent conditions.

d. Prepare general arrangement plans, sections and elevations to show the dimensions, layout and disposition of the structural elements including attachment points and lift points, as required for estimating purposes.

e. Prepare clearly annotated sketches to illustrate details of:
   (i) The connection at the underside of the cellar deck to the supporting structure.
   (ii) A typical lift point.
   (iii) The support to the deck crane.

f. Prepare a detailed construction outline method statement for the wellhead deck from design completion to the sailaway from the construction yard.