The Institution of Structural Engineers

Exam Preparation Guidance

Incorporated-Member to Chartered Member Supplementary Exam

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Contents

Disclaimer

This document has been produced by the Institution's Examinations Panel and is designed to aid you in your preparation. It contains vital hints and tips for each section of the exam but does not constitute a complete 'how-to' guide to answer the questions. This guidance should be used in conjunction with your other chosen methods of preparation and can be taken into the Examination as a handy reminder of the basics.

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Introduction to the exam, general tips, and time management

Introduction to the Exam

The Institution of Structural Engineer's' Incorporated-Member to Chartered Member Supplementary Examination (CS Exam) forms one half of the Professional Review process required for election to Chartered Membership (MIStructE) for existing Incorporated-Members (IMIStructE).

The Examination tasks you with demonstrating the validity of your further training, knowledge and experience since passing the Institution's Incorporated-Membership Examination. The Examination is a means of testing additional experience and progress gained in terms of concept design and takes into account the elements that are lacking between the Incorporated-Membership (IM) and Chartered Membership (CM) Examinations. Examiners must be satisfied that you have conveyed an understanding of structural engineering principles, an ability to initiate and communicate structural design and provide an effective solution to a structural design problem.

The Examination is three and a half hours in duration. Candidates must answer one question from a choice of three. All questions are marked out of 80 and have three parts which must be satisfactorily answered to achieve a pass:

Part a (54 marks) covers design concept, presentation, identification of various structural forms (including stability and loading transfer aspects) and a selection of the most appropriate materials. Candidates are required to propose two distinct, viable and sustainable solutions to a complex brief. The proposed scheme outlines must contain member sizing using concept feasibility calculations, these may be by the use of rule of thumb, e.g. span to depth ratio, or design guides such as Tata Steel Blue Book or Concrete Centre Design Guides. Where complex members are involved and considered as principal structural elements, such as a transition member, long span members or long cantilever etc. then calculations of a more detailed nature should be included under Part c. The scheme options must be reviewed and critically appraised with a simple comparative analysis provided to identify reasons for taking forward the recommended solution. Sustainability must be a used a key criterion for the scheme selection.

Part b (20 marks) requires the candidate to provide detailed drawings to outline the critical details within the chosen scheme, these details must be specific to the scheme and not generic.

Part c (6 marks) requires the candidate to Prepare design calculations to establish the form, size, and approximate A1-A3 carbon footprint for two principal structural elements including foundations.

The Examination presents three main challenges which will be covered throughout this guidance:

- Ensuring that all aspects of the brief are fully understood
- Being able to propose two distinct, viable and sustainable schemes that both satisfy the brief
- Producing detailed answers to all three parts of the Examination in the time available

General Tips

Past papers are added to the website to enable candidates to practise questions and familiarise themselves with the demands of the Examination.

The Examination is open book, but candidates should note that this can lead to a false sense of security. There is a lot to cover in the Examination and candidates may waste valuable time searching through reference books.

To save time, candidates are advised to prepare a folder with key reference documents and a contents page or index to help them locate information quickly.

Any design code or standard may be used to answer the questions in the paper, along with design guides, so long as reference to the code or design guides is consistent throughout and any assumptions made, or design data adopted (including loadings other than those specified in the question) are stated at the beginning of the answer.

When practising questions and during the Examination, candidates should be mindful of the following examples of what can be found in a poor solution, and will result in candidates losing marks:

- Unsafe structural schemes (this will result in automatic failure of the Examination)
- Only one solution, or an alternative solution that is simply a variation of the first, such as using a change of material or grid dimensions without other distinctive variations such as stability considerations and foundation options
- Lack of alternative forms of stability options being considered, e.g., braced, or unbraced structures
- The structure must include all elements of the building; the roof and ground slab are an integral part and should be considered
- Where a question defines the external finish as curtain walling or full height glazing, avoid the use of obtrusive diagonal bracing, unless the question clearly permits
- Lack of understanding of the geotechnical information provided in assessing foundation requirements
- The unnecessary use of piling where pads or raft foundations would be quicker and more economical
- Rambling essays that provide no clear picture of the structural integrity or viability of the schemes
- Design statements which are then contradicted by the concept calculations and/or details
- Unnecessary re-writing of the question or extracts from the codes of practice and standards
- No identification of scheme choice or reasons for selection
- Too much time spent on non-critical structural element design, or unrealistic loading cases
- Poor detail drawings outlining the critical details with insufficient information for estimating purposes
- Answers which are composed of generalities and do not relate specifically to the problem stated

The Institution asked candidates who previously passed the exam for their “top-tips”. Tips relating to the Examination in general are shown below and should be helpful to candidates who are about to embark on their own exam preparation:

- ‘Start collating your design notes in a paper file early in your career. The temptation these days is to rely on digital copies, but you won't have access to these in the exam.’
- ‘As you prepare for the exam, keep a note pad of things you need to research etc. I found this an invaluable tool. As I did questions, I constantly wrote notes of things I needed to read up on, then tried to spend one evening a week researching them. Lots of things repeat themselves in questions so patterns do emerge.’
- ‘Ask someone to review your practice attempts and give you feedback. It’s important to know that you are expressing your ideas and knowledge in an understandable way. It’s no use knowing good solutions if you can't present them well under the time pressure.’

- ‘Practise different methods/ styles of sketching and drawing schemes, plans and details under time pressure. Certain sized buildings/scales of drawing require different techniques to present your ideas in a clear fashion and within the time available. Get some coloured pens and practice with them.’

Time Management

Creating a timetable for the Examination will help candidates ensure sufficient time is allocated to each part of the Examination.

As candidates need to play to their own strengths, timetables need to be personalised and reviewed after “mock exams” to provide a bespoke guide on the day of the Examination. Table 1 shows an indicative timetable which candidates may find a helpful starting point when preparing their own timetable.

Table 1: Indicative timetable

Question Section	Activity	Mark allocation	Time allocation – based on marks (minutes)	Rationalised time allocation (minutes)
	Option investigations			10
a	Option 1 appraisal	25	56.25	60
	Option 2 appraisal	25	56.25	60
	Recommendation	4	9	10
b	Critical details	20	45	40
c	Calculations	6	13.5	20
	Overall Review			10

Several candidates who have passed the Examination provided their tips for time management:

- ‘Take a watch to the exam - you can't always see the clock depending on where you sit in the exam room.’
- ‘Sit full mocks in exam conditions – no phone, and everything you need. Select several exams and do not look at them before you sit down, so you can recreate the environment of opening a new exam paper on the day. I think I did four of these. Not fun, but it made the actual day run like clockwork - I didn't have a problem sticking to my time and had 15 mins to review at the end as planned.’
- ‘Rule of thumb, simple equations and design charts are very handy, as you will have very limited time to prepare your calculations. Condense and compile them in an orderly manner for easy access.’
- ‘In the exam, if you think you're running behind and won't finish, don't panic! Just get the essential points down and keep going. Make sure you have a stab at all parts even if it’s just a few notes.’
- ‘Timing is crucial. Plan out your time, write this down and take it into the exam with you. Allow for 10 to 15 minutes to think through your solutions. You don't want to decide part way through your answer you have picked the wrong solution. Allow some time for checking.’

Providing distinct, viable and sustainable solutions

Part a, asks candidates to prepare *'two distinct, viable and sustainable solutions for the proposed structure'* and then to recommend one of the schemes using sustainability as a key criterion. This section has a total allocation of 54 marks, which is divided into 25 marks for each respective distinct and viable solution, and 4 marks for the comparative analysis.

This is the most important part of the examination and should be considered as such as it sets the scene for the remainder of the answers required in the paper. Use the time allocated wisely and sensibly. Candidates must be competent in concept design and experienced in using a variety of materials; concrete, steel, timber, and load bearing masonry. Experience in differing construction techniques, such as prefabricated or insitu, is required. Stability options must be considered, such as braced or unbraced structures, and varying types of foundations; raft, pads, strip footings, or piling, both load bearing and retaining.

The following outlines the philosophy behind this section, as contained in the Exam Guidance and Instructions document:

'For the building structure questions, significant differences between the two schemes must be presented. Depending on the type of structure, significant differences may include, but are not limited to:

- *Stability: shear walls, cross-bracing, sway frames, monolithic rc frames*
- *Framing: column spacing and spans layout, precast, in-situ*
- *Foundations: piled, pad, strip, raft, ground improvement. Ground-bearing slabs versus suspended*
- *Materials: concrete (reinforced concrete, prestressed etc), steel, masonry, timber*
- *Load path*
- *Construction method: precast, modular, off-site, segmental, etc.*

Changing just one of these would not be enough to make a solution distinct. Candidates will gain higher marks by providing as many significant differences as possible, depending on the type of structure, and demonstrating their viability. The differences chosen should be relevant to the overall solution.

For the bridge question, each scheme should be based on a different form of bridge structure with different spans and/or different load paths to the foundations. Changing only the material of the bridge structure would not be enough to make a solution distinct.

Sketches may be used alongside text to describe the proposed schemes. These may be free-hand and are not required to be to scale but they must clearly convey the design principles being proposed.

Structural stability is a fundamental aspect of the scheme designs, and an unsafe structure, or instances where stability is ignored, will result in an automatic fail.

Candidates should demonstrate approaches in their designs which minimise the use of material through structural efficiency. Candidates should consider which materials are most likely to be appropriate for the brief, however this would not need to extend to undertaking carbon comparisons at this stage. Where a reuse opportunity is provided in the question it is expected that candidates will take advantage of this in their schemes and include the benefits in identifying the most suitable solution.

Concept feasibility calculations are required in this part of the question to justify the respective schemes structural elements which are to be included within the structural scheme options. The structural elements may be sized by using engineering judgment, rule of thumb, e.g. span to depth ratio etc. The candidate should develop, prior to the examination, knowledge and experience of element sizing by approximation and by the use of established design guides. Reference to such design guides or manufacturers literature should be noted where used. Design calculations to establish the form and size of two 'principal structural elements' within the chosen scheme, and identified as such, are not required in this section but are required to be considered under Part c.

All calculations should be clear and easy to follow.

The examiners are looking for candidates to clearly identify and address the main structural challenges contained within the question and marks will not be awarded for generic answers to any part of this section.

The statement above outlines the need for the two structures proposed to be distinct, utilising as many of the variables outlined as possible. Changes for each scheme should be significant, and not just a minor variation of the same, using alternative material, or a change of grid etc. The following gives a brief but not exhaustive indication of what could be considered in developing the schemes.

- For a long span question such as a warehouse, factory etc., depending on the span, the material alternatives could be steel, timber, or precast concrete, with the design being either a portal frame, column and truss, a two or three pinned arch, or cable stayed. The stability could be braced or unbraced, with foundation alternatives of pad or piled foundations. The grid centres will depend on the external finishes and the economic span of the supporting members, usually purlins and sheeting rails. Consideration must also be given to the centres of material expansion joints, such as blockwork, which may dictate a non-variable grid. If the building is long and requires a vertical expansion joint, then both parts of the structure must be stable.
- A multi storey building structure has many material alternatives and varying construction techniques that can be considered. These include insitu concrete, one-way or two-way spanning slabs, post-tension slabs, a steel frame with composite or precast concrete floors, timber frame post and floors, and load bearing masonry with insitu or precast concrete floors. An alternative may be the use of a combination of these materials such as part concrete, part steel superstructure, particularly where a penthouse or dormer roof is required. Stability options for any of the above could be braced, unbraced, or via a lift shaft. Often the grid may be predefined by the geometry of the building, or the end use such as a hotel or apartment building with defined bedroom locations. Changing the grid such that a column falls in the middle of an internal or external wall of a bedroom etc., where a window or door would be located, is an automatic mark down. The same applies for any diagonal bracing. The grid centres again may be dictated by the external finishes. If cavity wall construction is defined, the expansion joints for blockwork and masonry/stonework are normally at 6.0m and 12.0m centres, which defines a grid, whereas curtainwall has secondary support mullions so the grids could vary. The foundations, depending on the geotechnical information, could be pads, raft or piles. The combinations of distinct and variable options are endless, and candidates must be flexible and consider the above and any other alternatives.
- Where the building is of a low rise and conventional construction, such as masonry external elevations, then domestic type construction could be considered. This would include load bearing masonry with timber or precast concrete floors, total timber construction, or a light steel frame. Usually, this form of building is a braced structure using internal and external walls as bracing, diaphragms, or buttressing. If the building is low rise and fully glazed externally then an unbraced structure could be considered. Foundations should be either strip footings, pads, or raft foundations.
- The ground slabs for any development are an integral part of the building and must be considered as part of the design. The geotechnical information will give clear indication of the types of construction that could be

considered, such as site strip and ground bearing slab with edge beams, site strip, ground improvement and ground bearing slab with edge beams, or a suspended slab supported by internal and edge ground beams. If piled foundations are proposed with individual pile caps, then balancing beams must be considered to take out the moment due to construction tolerances permitted for piling.

- Similar considerations are required for the bridge question, again depending on the form of the question. Construction techniques, along with erection and installation considerations, are important for each scheme, plus health and safety considerations. The material considerations are usually precast or insitu concrete decking, with precast prestressed concrete beams, reinforced precast concrete beams, or insitu concrete beams and steel beams. Stability can be provided by bracing, diaphragm action or post tensioning.

How to appraise/differentiate between schemes

Having provided two distinct, viable and sustainable solutions in the first section of Part a, you are then asked to review and critically appraise your schemes and identify the solution you recommend, giving reasons for your choice. There are 4 marks allocated to this task, so it is worth spending some time on.

You can make this part of the exam much easier for yourself by ensuring that your two schemes are sufficiently different in the first place. Candidates often provide very similar schemes, perhaps just changing materials or making small adjustments to the structural grid. Not only will this lose you marks initially, but it also restricts your options when it comes to appraising the schemes. Remember, you are aiming to impress the examiners with your knowledge of different types of construction and their benefits and disadvantages. One word of warning; don't go too far and propose something which is clearly impractical just for the sake of being able to dismiss it in your appraisal.

The question requires you to '*review and critically appraise the scheme and identify the solution you recommend, giving reason for your choice.*' This implies a degree of discussion around the relative merits of each option and requires more than a simple list of the various scheme elements with a tick or cross against each, which is all that some candidates provide. Sustainability must also be a key criterion in your scheme selection.

There are many aspects which can be considered in the appraisal. Try to identify any key features or requirements in the brief of the question you are answering and make sure that you address these in your appraisal; for example, if your structure is in a remote or inaccessible location, availability of materials and skilled labour may influence your choice more than construction cost, whilst aesthetics is likely to be a more important consideration in an art gallery than in an industrial building. Some typical examples of things you might discuss in your answer are listed below; however not all of these will be applicable to every question and the list is by no means exhaustive:

- Economics - Consider the structural efficiency; for example, what are the most economic materials/construction methods for the spans you need to achieve? Also consider the impact choice of structural frame can have on overall cost; for example, flat slab construction may not provide the least expensive structural frame but could simplify service routing and thus reduce servicing costs in a heavily serviced building such as a hospital or could reduce the height of a tall building thus saving on cladding costs.
- Programme - Think not only of speed but also of construction sequence. Are there any restrictions such as outages which would make one of your solutions better than the other?
- Construction and demolition - How do your proposals affect safety during construction? Does either of your schemes require specialist skills or equipment? Does either require extensive temporary works? Similarly,

could one of your schemes present challenges for demolition or dismantling, for example post-tensioned structures?

- Location - Does the setting of your structure preclude the use of certain materials or construction techniques? Is transportation of materials difficult?
- Maintenance - Can one of your solutions be maintained more easily or safely than the other?

Other considerations could include robustness, construction quality, aesthetics, flexibility for adaptation or extension, environmental impact…. The list is almost endless, but please make your appraisal relevant to your chosen question's brief and avoid generic discussions.

Finally, don't forget that you have to prepare scheme designs for each solution with indicative member sizing using rule of thumb, or design guides, where calculations are required nothing more than a calculator. It is therefore clearly best to avoid recommending anything which would require complex software to design, or indeed anything you are not confident you can easily develop a design for in the time available. It is perfectly acceptable in the critical analysis to frame your arguments in a way that gives you the outcome you want, i.e., by emphasising the positives and playing down the negatives of your preferred scheme. There are many 'right' answers to every question and you will not be marked down for your choice if your reasoning is sound and clearly explained and your chosen solution is viable.

Guide to the preparation of scheme drawings

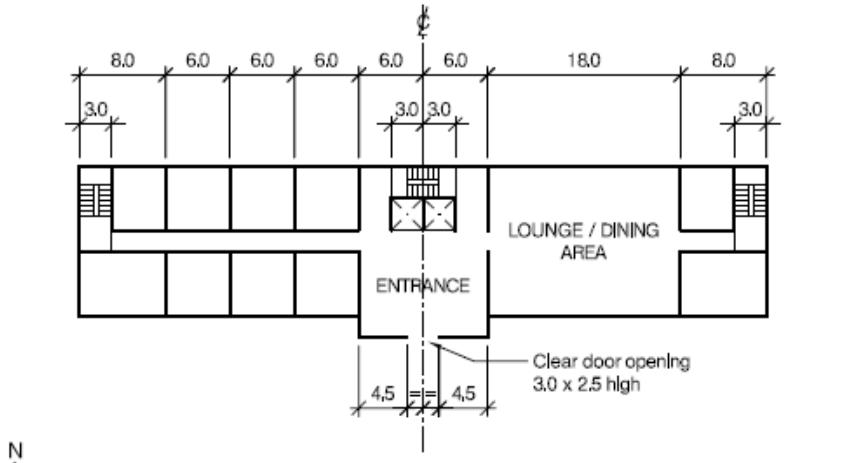
The scheme drawings for the two respective proposals must be equivalent to what would be expected of a candidate taking and passing the CM Examination.

The following provides an outline as to what would be expected and you will find examples of the following:

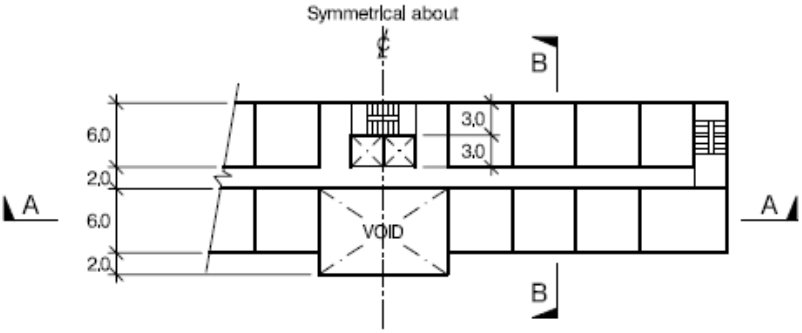
- Sections and Elevations
- Roof
- Floor Options
- Ground Slab – Foundations

This is not a definitive list of what of what should be included and candidates must determine what is needed based on the type of structure.

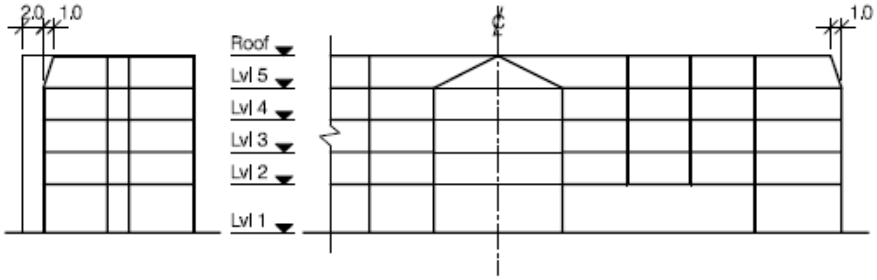
Example – CS Exam Question 1 September 2022



PLAN AT LEVEL 1



PART PLAN AT LEVELS 2 - 5



SECTION B - B

SECTION A - A

NOTE: All dimensions are in metres

FIGURE Q1

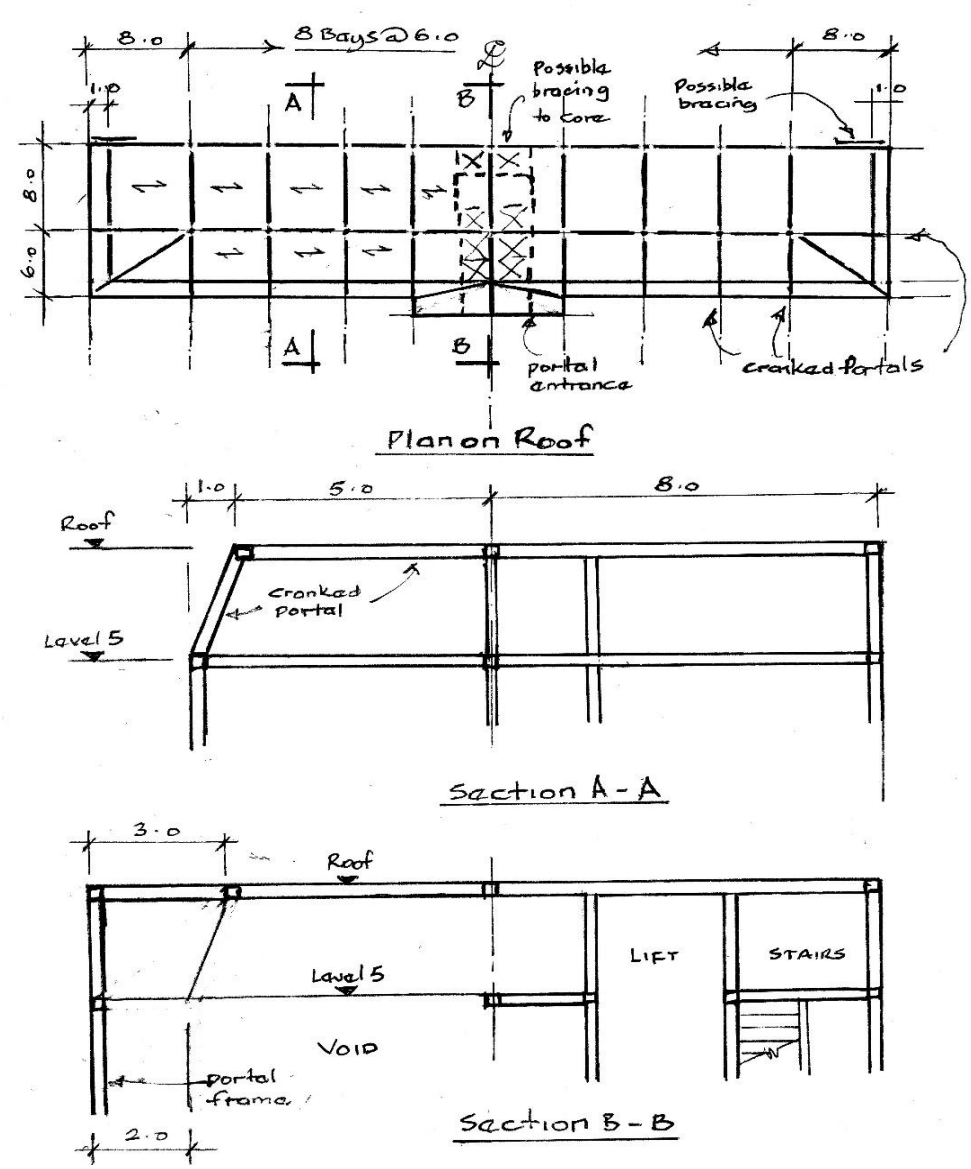
Structural Components for Arrangement and Details Consideration.

1. Roof Arrangement
2. Typical 3rd to 5th Floor Arrangement
3. Variation to 2nd Floor Arrangement
4. Ground Slab and Foundations
5. Relevant Sections

Sketch layouts can be freehand if preferred using the graph paper provided at the time of the examination and should be in proportion, which means that for a rectangular building the ratio of the building length to its breadth should be approximately correct. The plans should be dimensioned with some form of grid system and must include indicative member sizing.

Sections and Elevations

Sections and elevations are not always required and it is up to each individual candidate to decide whether they are necessary to clarify and enhance the proposed scheme information. They can again be simple and drawn freehand.

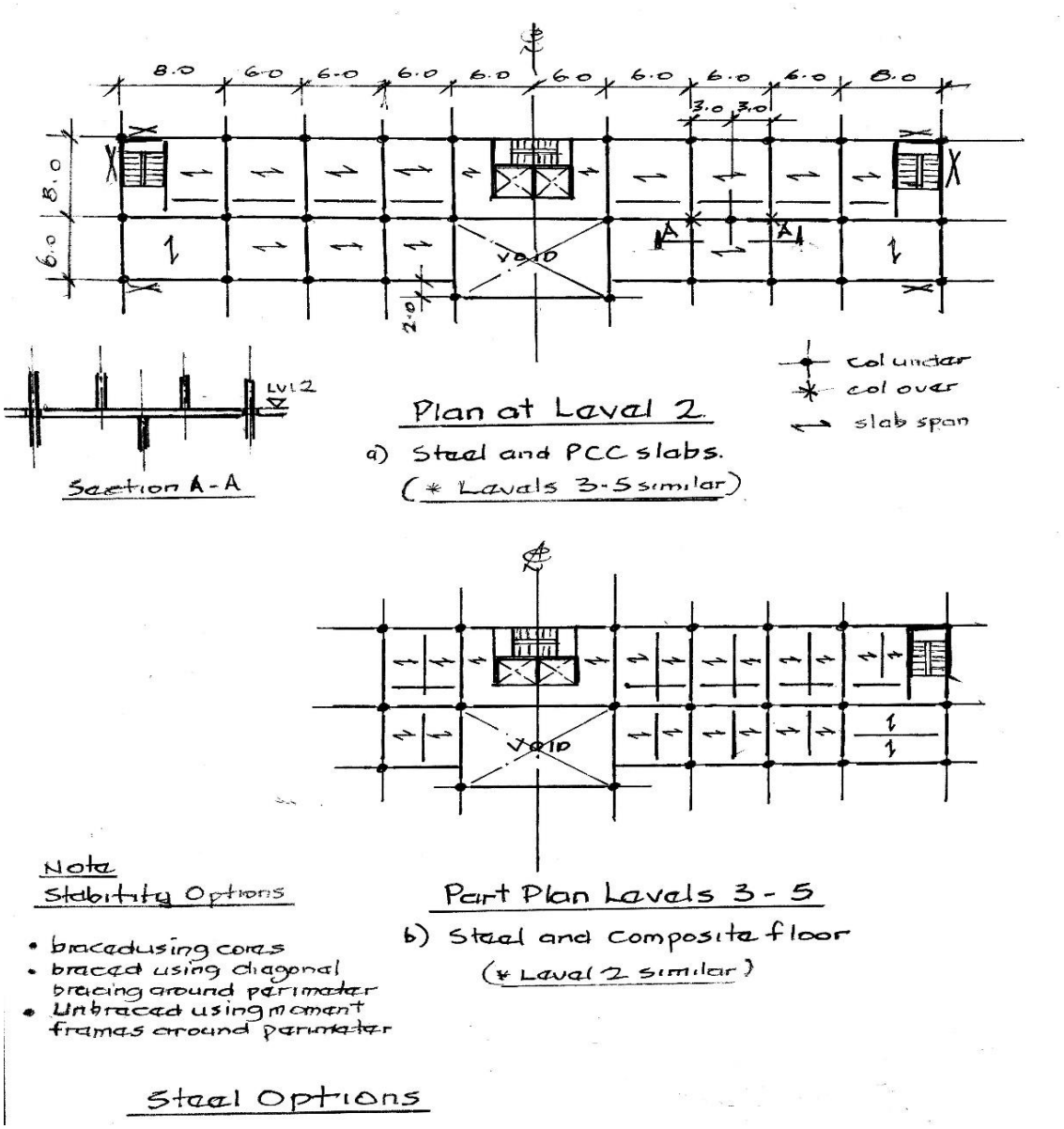


Roof

The above schematic roof arrangement shows a simple outline of beams and cranked portals at regular centres to accommodate the 1.0 splay required on three elevations. The South West and South East corners as indicated show a cranked portal arrangement but can vary providing it maintains the required profile. Providing a

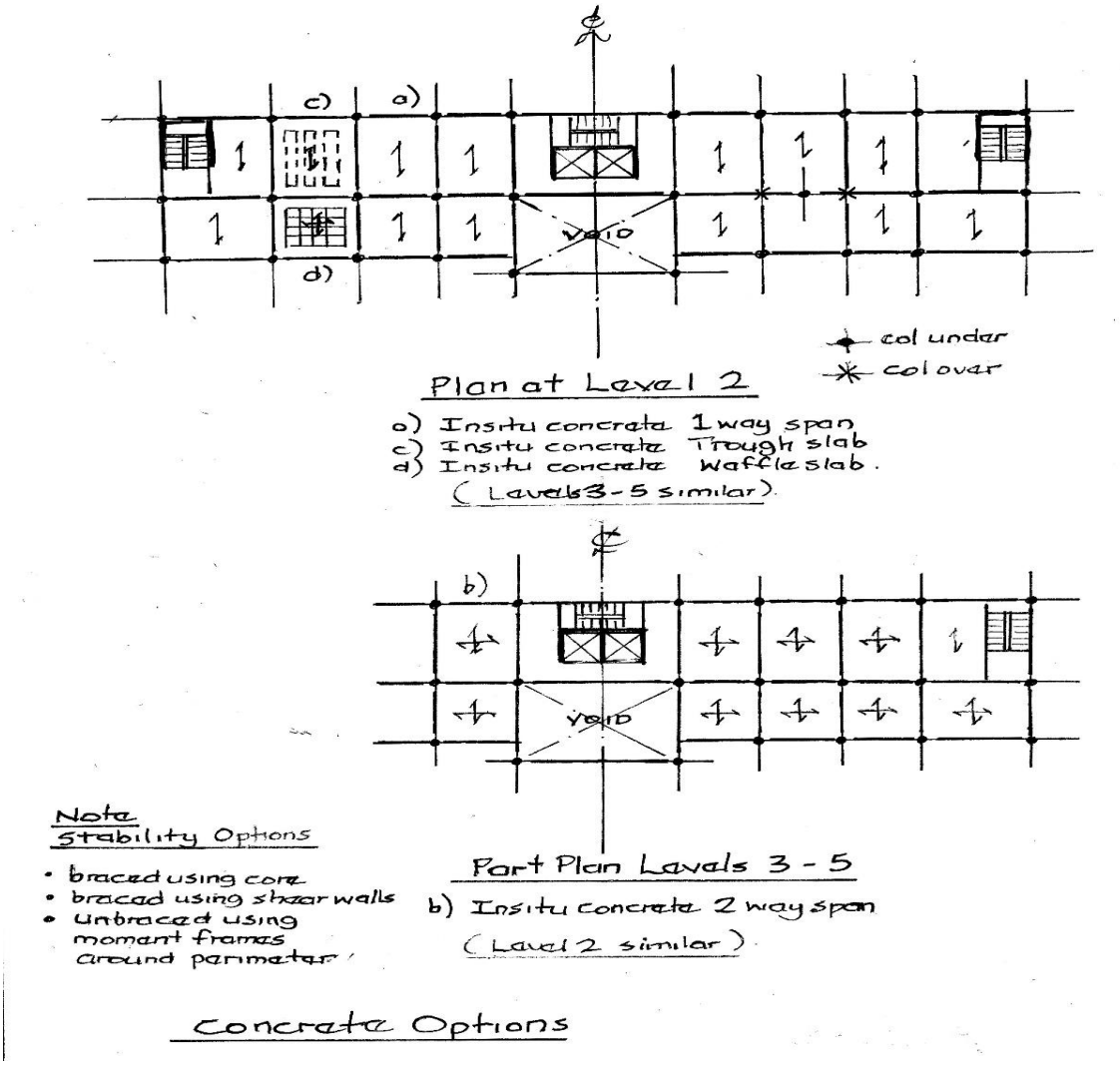
vertical column under the eaves beam at the head of the splay would not be acceptable unless a clear explanation is provided to the requirement of 6.0m minimum column spacing Indicative sections are provided to indicate the profile. Stability is provided by portal action. Indicative member sizing is required by rule of thumb, or design guides.

Floor Options

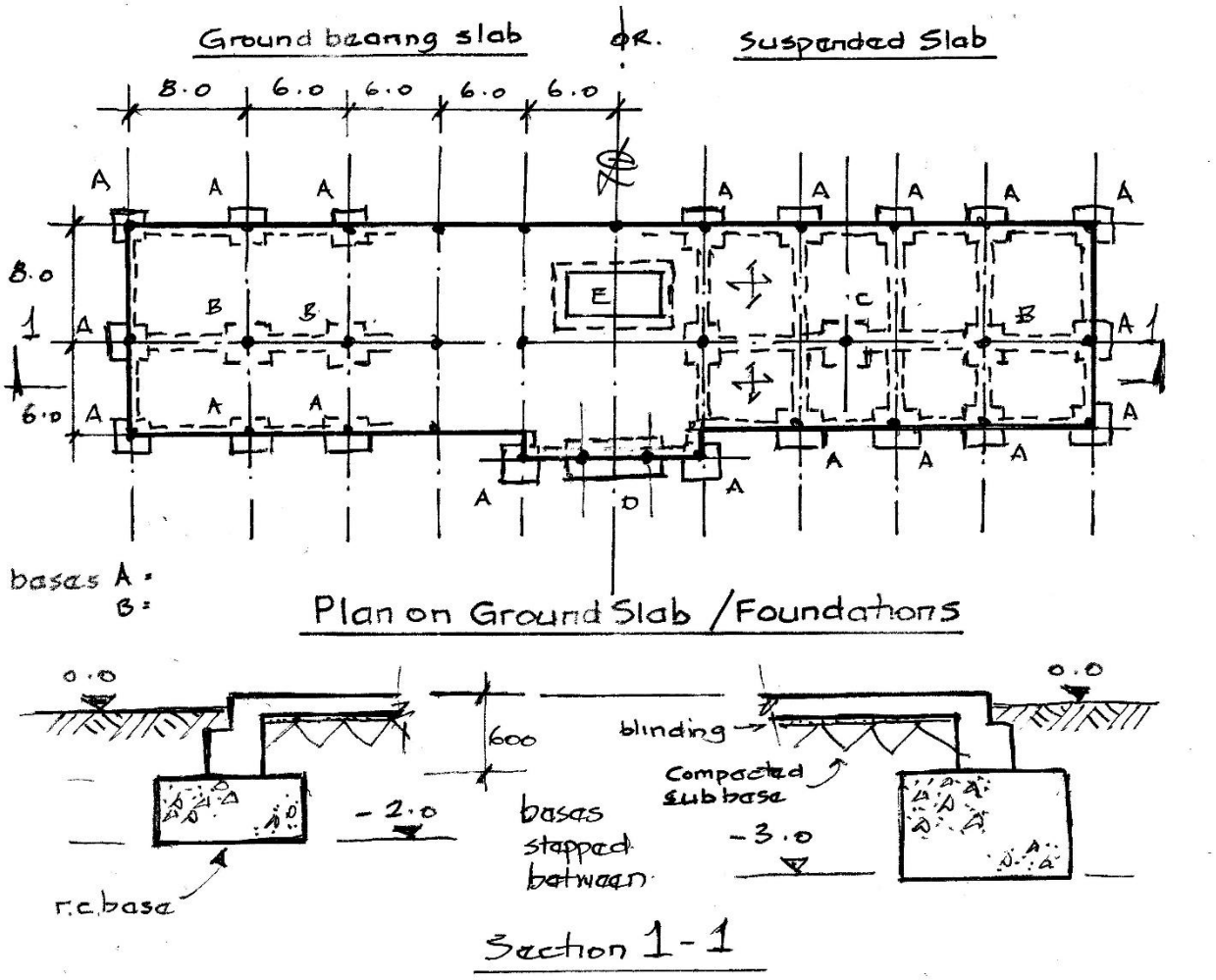


Steel. There are many permutations and combinations for steel frame floor options. The above sketch outlines provide some of the many options available using either precast concrete slab floors or composite decking. Stability can be provided by a braced structure utilising either the cores with shear walls, or diagonal bracing with any eccentricities of the system of stability being considered. Alternatively, an unbraced structure using moment frames in both directions would be acceptable. Indication of the respective member sizes must be included.

Concrete. As for the steel solutions above, there are many permutations and combinations for a concrete frame option. The sketch below outlines some of the many options available using a concrete slab construction, either one-way or two-way spanning. Similarly to the steel frame option, stability can be provided either by a braced or unbraced solution. Indicative member sizes must be included for all members.



Ground Slab - Foundations



The ground slab must be included in any proposal and is often omitted in scheme designs. The ground conditions in this question include a limited depth of made ground, so it is possible to have a ground bearing slab on compacted imported granular fill, replacing the existing made ground, with downstand edge beams. Alternatively, the made ground can be left insitu and the slab suspended and supported on four sides by internal ground beams and perimeter edge beams. The bearing strata is reasonably high and of sufficient bearing capacity to accommodate reinforced concrete pad foundations. Alternatively, mass concrete beams and pads could be used. In this instance a piling solution is not necessary and would be uneconomical.

The above sketches give an indication of the type of arrangements that would be expected in the examination, with the actual scheme options up to the candidate to propose. It is worth remembering that sketch proposals are easier to follow than wordy explanations.

Prepare detail drawings to outline the critical structural details

Part b asks the candidate to identify and prepare detailed drawings to outline the critical structural details within the chosen scheme. 20 marks are allocated to this part with around 40 minutes to prepare. This is the candidate's opportunity to convey their knowledge and experience in the preparation of critical details from the recommended scheme.

So why is it an important part of the question? There are various reasons which include the following:

- Helps to ensure that the proposed concept design is structurally safe and practical
- Shows that the candidate has considered any critical details that may need design consideration
- Enables a budget cost estimate to be prepared for the overall project

In each of the questions in the Examination paper, Part b, states:

'Identify and prepare detailed drawings to outline the critical structural details within the chosen scheme'

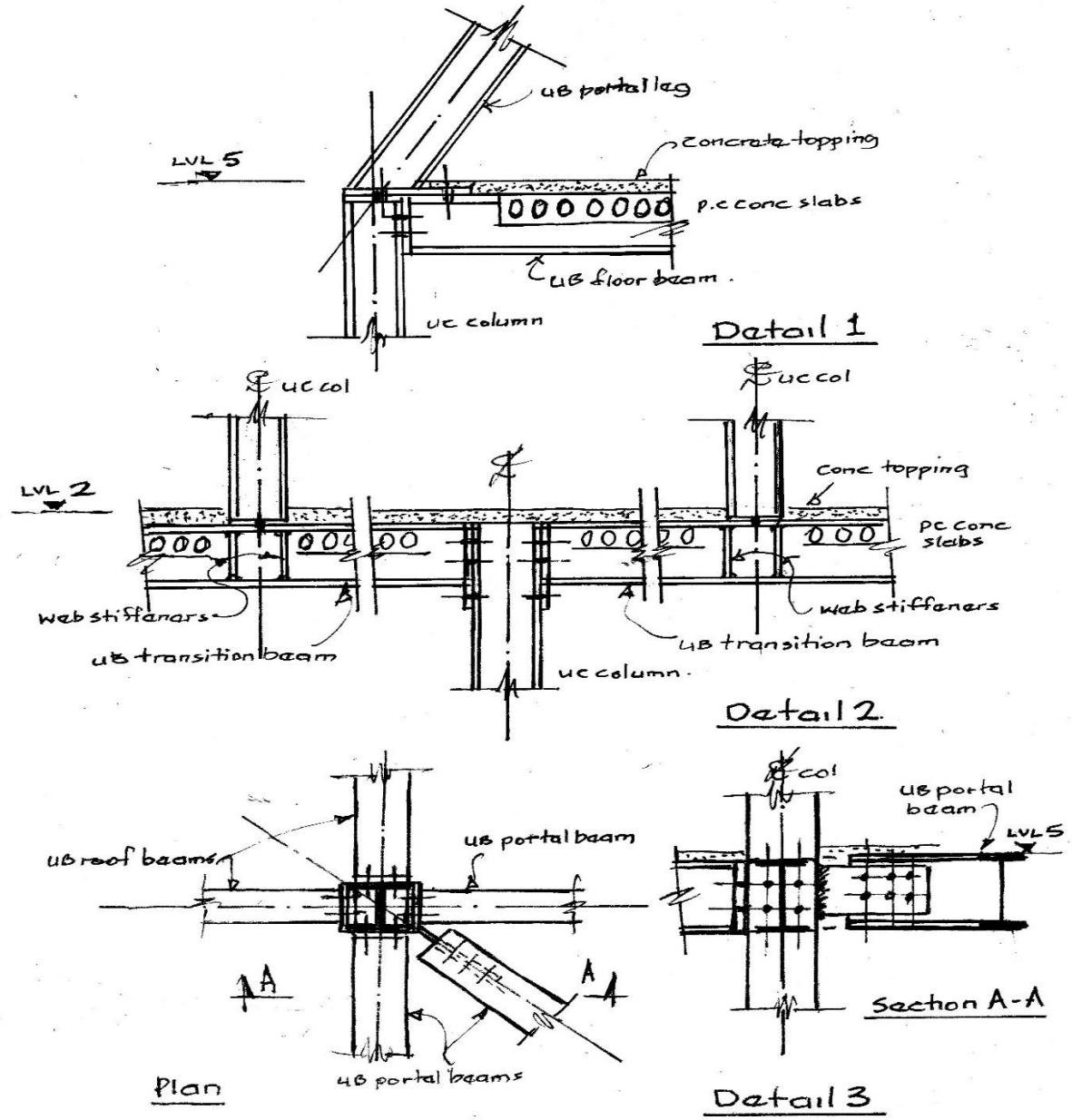
The critical details are subjective and unique to each individual scheme and it is up to the candidate to identify such details appropriate to their scheme. Generic details are not required or acceptable.

The critical detail drawings do not need to be to scale but should generally be in proportion and should be dimensioned with appropriate member sizes. In the Examination, graph paper is provided with clear horizontal and vertical lines to a set dimensional grid. Candidates should practice before the Examination preparing outlines from past papers using such graph paper and become familiar with the preparation of critical details using freehand techniques.

The actual critical details will vary depending on the question but may include cantilever connections, major splices, retaining wall details, or a reinforcement detail that has significant design considerations etc. A minimum of three details would ordinarily be expected.

The details should include all relevant dimensions and indicative member sizes.

As an example of the type of critical details that would be expected in this part of the question, the following has been prepared as an indication only of the type of answer anticipated. The candidate would be expected to produce at least three critical details which must be relevant to the scheme chosen and not generic details.


UB portal leg
Concrete topping
LVL 5
p.c conc slabs
UB floor beam
UC column
Detail 1
UC col
UC col
Conc topping
LVL 2
pc conc slabs
Web stiffeners
UB transition beam
Web stiffeners
UB transition beam
UC column
Detail 2
UB roof beams
UB portal beam
A
A
Plan
UB portal beams
col
UB portal beam
LVL 5
Section A-A
Detail 3

Calculations

Part c asks the candidate to prepare design calculations to establish the form, size, and approximate A1-A3 carbon footprint for two principal structural elements. This is the final part of the examination with 6 marks allocated and approximately 20 minutes to prepare.

The first task is to decide which two principal structural elements you will prepare. Do not waste time designing non-critical members or carrying out repetitive and simple calculations.

For the building structures questions the principal structural elements will be different for each scheme proposed, but the following gives an indication of possible elements to choose from:

- Main members in trusses, portal frames, arches etc.
- Transition members / transfer structures, members with high point loads
- Cantilever members
- Vertical structures where there is a high concentration of load and/or significant out of balance moments
- Members of stability systems
- Foundations including piles and pile caps, reinforced rafts and pads, balancing beams within the foundation system. Ground slab if appropriate
- Retaining walls
- Any special structural elements unique to the scheme

For the bridge structure question the principal structural elements will again be different for each scheme proposed, but the following gives an indication of the possible elements to choose:

- Bridge deck
- Main deck support structure
- Vertical structure
- Stability system
- Foundations including piles and pile caps, reinforced pads, retaining walls, etc.

Clearly most schemes will not include all the above.

Having established which two elements you are going to design, you are then expected to use your judgement and experience to decide the extent of the design checks required. Note that these are NOT supposed to be detailed design calculations; they are only required to *'establish form and size'* of the elements under consideration. Remember also that you only have around ten minutes to spend on each element. For most members, checks of bending and shear alongside a span/depth deflection check will be adequate.

The design calculations can be prepared in accordance with any current recognized national code of practice. The use of design guides shall not be used as the primary source of member sizing, but can be used to justify the actual sizing once the calculated design parameters are established for each principal element. Reference to such design guides or manufacturers literature should be noted where used. Please state clearly which design

codes you are using and any reasonable assumptions you have made, such as loadings other than those specified in the question.

The approximate A1-A3 carbon footprints for key elements can be assessed using a straightforward calculation of the element mass multiplied by the embodied carbon factor (ECF) of the material. Candidates can refer to the Institution's 'How to Calculate Embodied Carbon' document for suitable methodology and ECF values. Industry average ECF values are recommended, but other suitable values can be used. Candidates are encouraged to take advantage of the Institution's free on-line embodied carbon basics course in preparation. You will need to state clearly which ECF values you are using when preparing your calculations.

Embodied carbon ($kgCO_2e$) = Mass (kg) x Embodied Carbon Factor ($kgCO_2e/kg$)

A carbon calculation for a pile cap may be presented as follows (using recommended default value of material from the 'How to Calculate Embodied Carbon' guidance):

Material	Type	Specification/details	Recommended default value
Concrete	*In situ* concrete (unreinforced)[a]	UK C40/50	**0.138** **25% GGBS**[b]
Steel	Reinforcement bars	UK CARES sector average (EAF production)	**0.760**

2100x900x1400 C40/50 concrete – reinforcement 115kg/m3

ECF for C40/50 concrete = 0.138

ECF for Steel reinforcement bars = 0.760

Concrete: 2.1x0.9x1.4x2400x0.138 = 876 kgCO2e per pile cap
+
Reinforcement: 2.1x0.9x1.4x115x0.760 = 231 kgCO2e per pile cap.

Total A1-A3 upfront embodied carbon = 1107 kgCO2e per pile cap.

Finally, make sure that your calculations are clear, legible, and set out in a logical manner so that they can be easily followed and understood by a marking examiner. They should be of a standard that they could be sent for checking by an external third party without that party having to raise any questions. Add explanatory text where appropriate and don't skip steps. Remember, it is your job to demonstrate your design knowledge; it is not the examiner's job to try to interpret what you have done and if it is not clear to an examiner how you have arrived at your answer you will not get marks for it.

Windspeed Conversion Chart

The following chart is to be used for IStructE exams only and is intended as a guide for candidates who are using codes which provide a 10-minute averaging period.