The Institution of
StructuralEngineers

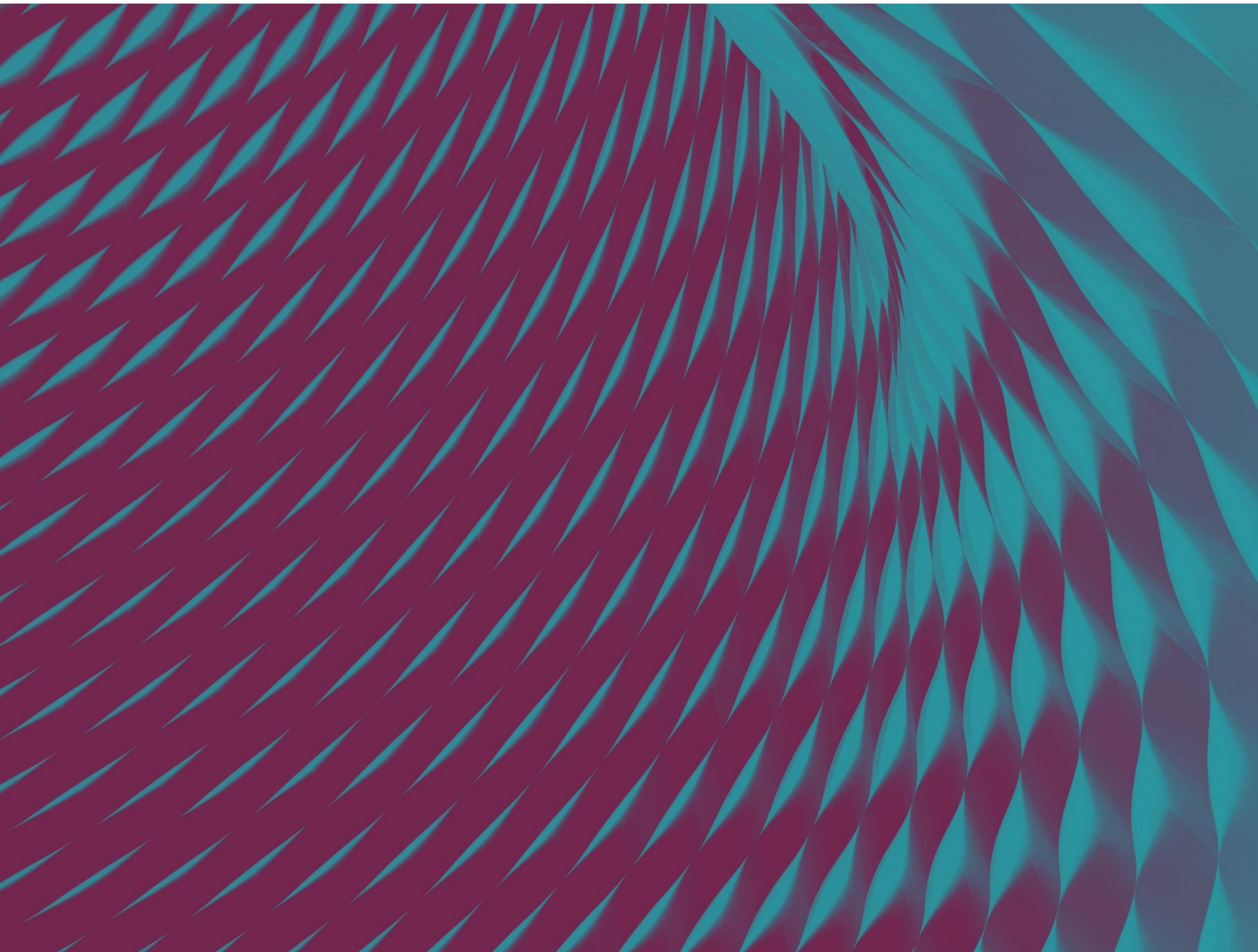
Examiner Report – July 2024

Chartered Membership Exam – July 2024

Author: Examinations Panel

Version: 1

Document date: 04 December 2024



Contents

Notes on the reports

The Examinations Panel, on behalf of The Institution of Structural Engineers, continues to review all aspects relating to the Chartered Membership, Incorporated-Membership and Chartered Supplementary Examinations and their relevance and role in assisting structural engineers to gain Chartered and Incorporated status within a worldwide professional structural engineering organisation.

Comments from the Examination and PRI Manager

All candidate exam papers were received back from the exam centres in good time and all scripts and pages were accounted for.

Candidates should make sure that they are aware of their candidate number and the location of the exam in advance of the day. The Institution sends out a reminder prior to the exam to check this information by signing in to the website and looking in the 'My Exams' section.

Candidates continue to leave page numbers blank on scripts which results in Marking Examiners not always being able to follow an answer script logically. Candidates are reminded that the final 5-10 minutes of the exam should be used to ensure that their papers are in order and ready for collection at the end by the invigilators.

A general observation from examiners is that many candidates continue to adopt a formulaic approach in their responses to Section 1B and 2E, using 'standard' wording and sketches possibly taken from an exam preparation course. Candidates should note that examiners are looking for bespoke solutions which address the specific requirements of the brief and marks will not be awarded for generic answers.

The Examinations Panel have created and made available a preparation guidance document that all candidates are encouraged to download and use as part of the revision, as well as taking a copy into the exam for any last-minute reminders. Focus should be on the recent changes to the requirements, such as the sustainability elements and the fact that a programme of works is no longer needed to be produced in Section 2E.

Question 1 – University teaching hub

This question required the design of a 3-storey teaching hub, with a roof top plant room set back from the perimeter of the main building footprint. The building, rectangular in plan, was to be clad in masonry up to Level 4 (plant room level) which allowed for shear walls or steel bracing members to be placed in masonry panels between glazing panels. The plant room was to be clad with a lightweight panel system.

The key challenges associated with the question were:

- Ground conditions which varied from the north to the south of the building requiring candidates to consider solutions which founded at varying depths on a consistent stratum in order to avoid differential settlement.
- Large open plan lecture theatre in the centre of the building.
- Roof top plant room with different constraints on the number and spacing of columns compared to the lower floors, thus requiring longer span structural elements for the roof structure and a possible transfer structure at Level 4.

Section 1a

Materials for the frame could be steel, concrete (flat slab or beam & slab) or timber. A concrete floor slab was not a client requirement, so CLT timber panels supported on a steel frame could have been proposed as an alternative concept. From a stability perspective, there were several options which could have been used to brace the building, including the use of the 3no. well placed stair/lift cores or, alternatively, utilising shear walls or vertical diagonal bracing set within the masonry panels of the perimeter walls.

There was virtually no consideration given by candidates to the external masonry cladding, with limited discussion on the need to control building deflections, the option to use a lightweight steel framed inner leaf and the need for wind posts or masonry support. Being aware of these secondary elements could potentially have attracted additional marks.

The column spacing rules allowed for a variety of grid spacings, with 6-12m a suitable range. A significant number of candidates utilised the same (or very similar) grid for both schemes and simply changed the material from steel to concrete, resulting in two schemes which were not sufficiently distinct. Too many candidates also used excessive column spacings of up to 18m, failing to consider the serviceability or vibration issues that might arise with such large spans. The resulting beam sizes were also considered a poor choice from a sustainability perspective.

The different column spacing rules at roof level were set to test candidates on their ability to change the structural grid at an upper floor level and also deal with longer span structural elements at roof level. Unfortunately, too many candidates, who had designed an RC frame to Level 4, continued to roof level using a long span (often up to 18m) RC beam & slab solution. This was not an appropriate concept, and the better candidates recognised the benefit of changing to a more sustainable lightweight steel framed roof structure and deck, rising from the Level 4 RC frame.

The building could either have been supported on piles or pad foundations. Where piled foundations were proposed, 450-600mm diameter, taken to rock level, would have been considered appropriate for a building of this nature; however, too many candidates proposed a bored pile solution in excess of these diameters, which was considered uneconomic and lost marks accordingly.

Pad foundations were appropriate as long as due consideration of the varying depth of the stiff clay layer was taken into account. Few candidates proposed the use of trench fill or mass concrete as a means of transferring the loads to the same stiff clay layer and allowing the construction of all pad foundations at one level. The use of such a technique would mean that the trench fill could be installed without the requirement for anyone to enter the excavation, which would have been a clear health and safety risk. Candidates who proposed the installation of reinforced concrete foundations at 3-4m depth were therefore marked down accordingly.

Raft foundations were also a common solution bur not one considered appropriate for the ground conditions at this site. Several candidates either placed the raft structure at a depth of 3-4m, leading to significant excavation and disposal of material, or placed it at a higher level without explaining how differential or rotational settlement would be dealt with. The use of a raft foundation received lower marks compared to other more appropriate solutions such as those discussed above.

Where candidates had proposed steel and concrete framed options, there were some that proposed piled foundations for the steel frame and shallow foundations for the concrete frame, not acknowledging that the concrete frame was the heavier building and more suited to a piled solution.

Generally, the sketches provided lacked clarity as to the proposed concept, largely due to candidates showing multiple levels on one plan – see detailed comment below in Section 2d. A large number of candidates also prepared lengthy calculations in this section, which is not a mandatory requirement. Examiners are expecting that candidates can generally propose most sizes in this section of the exam, based on span-depth ratio. Limited calculations may be required, for example to size a transfer beam or undertake a load take down to determine whether pad foundations are viable.

The scheme comparison continues to see too many candidates provide very generic responses with little or no reference to sustainability, which gain few marks. The examiners were looking for a discussion, using sustainability as a key criterion to critically appraise each scheme. Consideration of local practices or availability of materials were not considered acceptable reasons for choosing one scheme over another.

Section 1b

The communication was on the whole reasonably well attempted. The question was looking for candidates to suggests what changes could be made to the brief in order to reduce the use of materials, whilst maintaining the number of floors as indicated. Potential options included:

- Relaxing the column spacing rule in the plant room to allow more columns and therefore reduce the spans of the roof members.
- Moving the plant room to the ground floor where the loads could be more easily managed.
- Reducing the loading in the plant room by designing instead for specific weights of plant, while making some allowance for future installations.
- Removing the roof over the plant room and having an open-air plant room, noting that the equipment may need to be upgraded accordingly.
- Centralising the two cores on the east & west elevations and removing the northern core.

It was also important that candidates explained the effect of the proposed change on the structural design; for example by providing a discussion of how the removal of the northern core would impact the distribution and quantum of lateral loading on the two remaining cores if that was the chosen method of bracing.

Unfortunately, many candidates provided a communication which was too brief and contained suggestions which offered little to reduce materials, showing a lack of experience. Many candidates also suggested a better design than their chosen scheme to save material rather than making changes to the brief, serving purely to demonstrate that they had not achieved an efficient design in the first place.

Section 2c

Calculations were generally well dealt with, and most candidates commenced with an introduction which provided useful information such as a note of design codes adopted, loadings, a list of the elements designed and assumptions. Too many also provided a lengthy wind loading calculation wasting valuable time which could have been better spent on the design of structural elements.

A number of examiners noted the tendency of candidates to focus on the easier calculations such as beams, slabs and columns, while avoiding the more complex calculations for stability and transfer structures. Calculations also often lacked a clear narrative and would have been enhanced by including a simple sketch showing spans and loadings.

Candidates should appreciate that to maximise marks in this section, then a range of elements (typically around 7no.) should be designed. In this question this could have included, floor beam(s), transfer structure, column, roof beam/truss, bracing system, foundations and carbon. If, for example, there are two or three similar beams that need to be designed, then provide a calculation for one beam and either use rules of thumb or condensed calculations to confirm the sizes of the others.

The carbon calculations were generally well attempted.

Section 2d

Similar to comments from previous examiner's reports, the drawings continue to be an area of weakness for a significant number of candidates. For this question, drawings were generally of poor quality with the majority opting to show multiple floor plans on one plan. This approach was not appropriate for this building and most examiners commented that this led to a lack of clarity as to the proposed concept. Prospective candidates for future exams need to practice drawings and consider whether their selected presentation will be clear and suitable to convey the concept and for cost estimation purposes.

The structural concept for this building was best represented by a full plan at Level four and roof level, along with a partial foundation plan, a full building section, and cut-outs or part plans to illustrate the structure of the lecture theatre at Levels 2 & 3.

Details continue to be an issue, with many producing RC details which were not considered critical. It is important that candidates review the proposed building and provide details that would add benefit to someone trying to understand the concept and develop a cost estimate.

Section 2e

Too many candidates provided brief generic method statements that could apply to any building, and accordingly lost marks. Good candidates were able to:

- Provide sketches to show proposed cranage positions with respect to site layout.
- Provide detailed sequences of work for both the substructures and superstructures.
- Highlight any significant health & safety issues.

- Discuss the varying subsoil conditions and the practical issues to be overcome when installing the foundations.
- Consider the requirements for any temporary works for stability, transportation and splicing of long span elements.

It was clear that some candidates appear to lack site experience, which is a critical aspect of being a chartered engineer. For example, a number of candidates proposed impractical solutions such as erecting the steel frame to Level 2, followed by pouring the floor slab at that level, before re-commencing with the steel erection to the next floor level, and so on. In reality, the entire frame would be erected, plumbed and aligned, baseplates grouted, and metal deck installed before pouring the floor slabs in sequence.

Question 2 – Multi-storey residential/student accommodation development

The main challenge behind this question was how to deal with geometric constraints. This was enforced within the question by two key elements; an existing ramp that had to be retained and built over and a second staircase that did not extend into the basement, referred to as Level L-1. The building is relatively small, with it being 8 storeys high, and having a plan size of 21m x 36m. This does place it within the Higher Risk Building category (HRB), hence the inclusion of 2 staircases to ensure the travel distance for fire escapes are within the current regulations.

To counter this restriction, there was a relaxation on column spacing to 4m apart, which is highly unusual for a building such as this, which typically has an irregular column layout with minimum spacing of 5-6m. This is largely driven by residential unit layouts that are defined by the architect. For reasons of expediency, this is not addressed in this question and would have added yet more geometric burdens to an already constrained set of criteria.

An appropriate design for the structure is a flat slab with a transfer structure at Level 2 to let the building over-sail the ramp. Lateral stability can be achieved via a shear wall on the western face to counter torsion effects in the floor slab while using the primary stair and lift/elevator core that does extend into the basement. Alternatives to this include using a sway frame on the western side of the building to provide lateral stability and a steel frame with transfer trusses and precast concrete planks. It would also be possible to have the roof structure as a light-weight steel frame on an in-situ reinforced concrete structure.

The responses to this question from candidates were largely inadequate. Most submissions breached the geometrical constraints described above, with candidates using the second staircase as a shear core, despite it not projecting into Level L-1, i.e., the founding level. Other contraventions related to column spacing.

The ground conditions, which were dense gravels and sand, should have led candidates to propose ground bearing foundations; however many used piles without justification. There were two viable forms of footing for this building: discrete pads and strips or a ground bearing raft.

When tasked with reviewing the brief in the context of sustainability and carbon costs, most candidates did seem to address this sufficiently, with options including removing the ramp or rotating the building so that it did not need to over-sail the existing access point. Critiquing the design brief demonstrates candidates' understanding of it as well as providing an opportunity to reduce material usage.

The quality of the calculations that were produced was generally adequate; however some did resort to using load/span tables for primary elements without designing the element itself, which is not acceptable.

The lack of symmetry of the building meant that a number of floor plans had to be produced and there was also a need to create a long section through the building to indicate how the structure was to bridge over the existing ramp. Answers that included all the salient components of the structure, including critical details such as the transfer structure and foundations, were of adequate quality; however a small number of candidates appeared to run out of time and failed to complete either section 2c, 2d or both.

The method statements should have addressed the presence of the existing ramp and the need to ensure that the transfer structure would have achieved adequate strength to support the structure above before starting to construct the upper level. Few candidates addressed this, with most choosing to produce a generic sequence of works. The geometric constraints of this question presented buildability challenges that candidates should have been aware of and countered within the method statement.

In summary this question presented unique challenges with respect to spatial requirements that many candidates failed to understand or appreciate. A competent structural engineer must be able to develop structural forms that are in sympathy with the reasonable geometric constraints present within the building. Ignoring and/or failing to address such constraints leads to inappropriate designs that are not fit for purpose.

Question 3 – New Coastal path cycleway and pedestrian bridge

The question was intended to provide candidates with an opportunity to seek a highly efficient lightweight structure while still offering scope for a range of other solutions. The decks were shown as being offset and staggered in height. The site was a difficult site in that the land around the foundations was poor and therefore some form of cranage or launching would be required. Launching would require excavation around one end of the bridge, but this could be back filled with the extracted material. Difficult ground conditions around the base of the existing slopes also played into the thinking, making the first span longer than might be required for an optimal solution unless the candidate made use of smaller foundations that avoided the ground anchors, which were the second major constraint on the foundations.

The combination of the constrained foundations and the eccentric decks invited a solution of a steel box girder that could fit between the decks with the top deck running directly on the top flange of the box. This would effectively move the deck and piers north and away from the ground anchors such that they were no longer a constraint. This in turn would allow a much more efficient use of the span lengths and produce the lightest solution. Several candidates used the box girder, recognising the benefits it realised in terms of lightness and control of rotation, but very few took advantage of the shifting of the piers northwards. Nevertheless, there were plenty of other span and deck arrangements that worked.

A few candidates attempted very long span solutions which were grossly uneconomic and failed to consider the environmental constraint of minimum impact. Whereas a long span might have zero impact on the foundations on the soft sand slope, it resulted in a far heavier bridge with major foundations on the cliff top.

Section 1a

Section 1A scheming was, in general, very poorly presented, with very rough freehand sketches and an overall absence of essential dimensions and information needed to fully ascertain their viability. In many cases, candidates gave no indication of the proposed span arrangement in relation to the exclusion zone and anchors. This is critical, as the candidate must show that the structure is compliant with the site constraints. Often, there was no indication of the proposed articulation arrangement and thus the load path was unclear to the examiners. For a bridge of this form (and indeed most bridges) the method of construction is critical for viability of the bridge and is a governing factor in determining the viability of the proposed schemes. Sadly this was ignored by many candidates. It must be stressed that if the designer fails to consider the method of construction then the design is incomplete. There are too many examples of bridges being designed as effectively unbuildable, which cause considerable additional design work for the constructor and cost to the client.

As always, the brief requires the proposal of two distinct and viable solutions; some candidates continue in suggesting two very similar schemes with the same span arrangement, articulation, and load paths and simply a different type of deck (often without any logic or understanding of why the deck types should be used). Options existed for the foundations, which could have been either pad footings or short piled foundations. The stability of pad footings needed to be evaluated due to significant eccentric loading. Many candidates suggested pad footings and ignored the uplift effect on the foundation.

Section 1b

The question called for changes to the brief to reduce material usage; however, rather than suggesting changes many candidates merely refined their design or conducted value engineering within the bounds of the original brief, which is deemed design development. It is the Designer's responsibility to initially devise a cost-effective solution that adheres to the brief's requirements. An obvious change to the brief would be to eliminate the level disparity between the two decks, allowing them to be merged. Another would be to investigate the design of the ground anchors and to determine less onerous interaction zones which would permit more scope for foundation positions and for reducing span inefficiencies. The best suggestion would be to move the bridge a few metres north which would remove the influence of the ground anchors completely. Only a few candidates embraced this lateral thinking.

Section 2c

Many candidates proposed combined piers with cantilevers that supported individual decks. The cantilever support then becomes a critical structural element and should be given due attention. Unfortunately, very few candidates include such essential calculations in their designs. The deck layout results in large eccentric loadings on the substructure and foundations. Many candidates overlooked the effects of such eccentric loading and designed the substructure and foundations solely for pure vertical loads resulting in unsafe structure. Despite the question explicitly requesting the inclusion of approximate A1-A3 carbon calculations for each principal element, many candidates still failed to include them. There is a climate emergency and so such calculations are as important as deflection, strength and durability.

Section 2d

Drawings were often poorly presented and were more in the form of rough line sketches rather than standard drawings showing plans, elevations, sections, details and notes. The purpose of the drawings is to provide an estimator with sufficient detail to price the design, therefore they need key dimensions for all elements and sufficient information to define the outline and the means of articulation. For the critical details, many candidates presented typical details very generic in nature and not specific to the site conditions and the specific structures that they proposed. For this bridge, the abutment details are key, as are the complex supporting columns where they need to cater for two different levels of deck. Similarly, span arrangement and articulation should relate to the bridge's location in relation to the surrounding environment and ensure there are no conflicts with the exclusion zone and anchors; however, very few candidates furnished this vital information.

Sadly, some candidates merely replicated isolated product details from a manufacturer's catalogue, such as bearings, movement joints, or standard details of a steel section without tailoring them to the specific application of the proposed scheme, thereby failing to add any value to the drawing – examiners will provide no credit to generic sketches unless they relate to the exam question. Drawing notes are essential in engineering drawings to give basic information such as material grades, finishes and any other notes specific to the structures being proposed; however, this was overlooked by many candidates and marks were lost. Issues associated with construction should also be added, although if they appear in the method statement then appropriate credit will be given to the candidates.

Section 2e

Part 2e asked for a detailed method statement for the safe construction of the works; however, the proposed method statements were generally presented in the form of an oversimplified sequence of headline activities in very broad terms. Key construction methods, including the construction of the substructures and foundations and the erection of the superstructure should be discussed and the method statement should also cover the anticipated plant and equipment to be deployed, the likely temporary works required and any safety measures considered. Considering the soft sand, it is anticipated that certain treatments will be applied when deploying plant and equipment for operations in the area. While the question does not explicitly request it, the method statement should ideally include sketches to clarify the proposed method, detailing the plant and equipment to be used and their arrangement.

A bridge design is not complete unless the construction method is clear. A designer will assume a final stress state – it is vital then for the designer to know how the bridge will get to that state and tell the contractor what constraints exist. If not, the design is incomplete and candidates need to be aware of this.

Question 4 – Industrial building with overhead cranes

The building is essentially a rectangular box with overhead travelling cranes and associated offices at one end. The main challenges of the brief are the 20m large spans, deflection constraints of the travelling overhead cranes, the 120m total length of the building, the sloping northern half of the site and the varying ground conditions.

In view of the large spans and overhead travelling cranes, the superstructure lends itself to steelwork. The soft material at the northern half of the building may need a different type of foundation compared to the southern end where good uniform ground is found. A movement joint could be considered at around mid-length at the change in soil conditions which would also take account of the 120m length of the building. Water at 5m below ground level is below ground-bearing foundations but to be considered for piled option. The building lends itself to several distinct options with different stability load paths.

Section 1a

The superstructure options are a braced steel frame in both directions with columns with pinned feet, primary roof trusses spanning east to west (either 3-span or 3 individual spans), and secondary members spanning 10m north to south. Crane runway beams could be supported on the frame columns. Alternatively, runway beams could be supported by independent columns, in which case there is an option for roof trusses to span the full 60m. Another option would be portal frames spanning east to west and moment frames or braced end bays in the other direction. A further variation would be a braced frame with the main roof trusses running north to south over the internal columns and secondary rafter beams or trusses spanning east to west with the benefit of repetitive members. The offices could be part of the workshop structure or could be made independent by the introduction of a movement joint. The offices superstructure could then be a braced frame with various options for the floor beams and slabs.

For foundations, the ground conditions would enable ground-bearing types to be used such as strip footings with local thickening at columns, and ground-bearing workshop slabs. At the sloping northern end of the building the options are suspended floor slabs off varying height columns or ground improvement and backfill to raise ground levels with a perimeter retaining wall. The brief gives no restriction as to the plot size so it might be possible to extend the backfill to form an embankment. A movement joint between the northern and southern foundations would address the different support conditions between the uniform ground at the south and the made ground at the north end, unless piled foundations were used. Piling would avoid having to improve or replace the soil at the northern half and provide the same type of support over the whole building. The relative cost and environmental benefits would have to be considered.

The majority of candidates proposed the obvious portal frames versus braced frames options. Roof trusses spanning 60m E-W or with 3no. 20m spans were the main alternatives proposed. A few candidates proposed internal crane rail columns independent from the frame columns supporting the roof; however, only a few schemes had crane rail columns fully independent as the outer rails were still generally supported by the external frame columns thereby creating a mismatch of lateral deflection resistance to the crane rails. The majority selected the braced frame option as stiffer than portal frames, however a minority selected the portal frame option despite recognising that it was less stiff. Foundations proposed were ground-bearing or piled foundations to the columns and to slabs. The use of a thick uniform raft would require a lot of material given the significant difference between column and workshop slab loads and the large column spacings and were therefore difficult to justify. The workshop slab over the sloping northern half of the site was either ground-bearing on engineered fill with perimeter retaining walls or suspended on varying height columns off pads or pilecaps. Crane support columns or vertical diagonal bracings within the 20m crane bays would obstruct the use of these bays and were therefore contrary to the brief. The structure for the offices was generally integral with the workshop superstructure but some proposed a movement joint. In the workshop, a movement joint was provided by some candidates between the level southern half and the northern half due to the sloping ground and different ground or support conditions.

Section 1b

Changes to the brief to reduce material usage could include relocating the building southward away from the slope, rotating it away from the slope, querying the minimum column spacing both along and across the building, the height to the crane and above it to the roof, the capacity of the cranes and moving the side door southward away from the edge of the slope.

Candidates included rotating the building, crane capacity, column spacing and moving the side door. Candidates who offered options to optimise their design were missing the intent of the question.

Section 2c

The principal elements would be the crane rail beams, supporting columns and foundation, the roof truss or beam, supporting column and foundation, stability bracing and associated foundation and northern retaining wall unless suspended floors used. The office structure could be by span to depth ratio as it is relatively straightforward.

The majority prepared calculations for only a few key elements. The standard of calculations varied from over-simplistic to too detailed. The better candidates made good use of sections tables. The majority prepared brief carbon calculations.

Section 2c

Drawings required would include plans at roof, crane rail and foundation levels as well as transverse and longitudinal sections. All candidates produced part or full plans and sections for the workshop but some also included the offices. Drawings were generally of a high standard and some of the hand-sketched ones conveyed sufficient information. Details were often either too few or not critical. Such details would include, for example, crane rail connection to internal or external column, roof to column connection, stability bracing connection, movement joints and retaining walls if any. Notes provided were often generic or too few.

Section 2e

A detailed method statement for the safe construction of the works from the designer is to address structural aspects that a contractor would need to know. Such aspects would include, for example, verifying ground conditions to close out design assumptions/ parameters, splicing long members taking account of method of lifting, erection and construction sequence and monitoring for any relative settlement during construction.

Some responses appeared to be stock answers and did not address the specifics of the questions or included aspects that the solution did not have. Method statements were often detailed at the early stages (surveys and excavation) but then referred to ‘common construction practices’ for the upper levels. Aspects such as craneage of large / long element, splicing of steel, sequence of crane installation and ground floor construction were addressed in better papers. The construction of the offices was generally omitted.

Conclusion

The brief was well addressed by most candidates resulting in the overall pass rate being greater than the historical average. The crane rail design would probably not be familiar to some candidates but was adequately handled by successful candidates.

Question 5 – Existing warehouse building

This question was developed to support the Institution's drive for more sustainable construction and re-use of existing buildings and materials. Examples of re-use questions have been very limited in past exam papers and it is felt that candidates should be given an opportunity to attempt such questions to demonstrate their knowledge and experience of working with existing buildings, including their appraisal and assessment, change of use, extension and alteration.

The question involved a change-of-use of an existing warehouse building to residential accommodation with the addition of two floors, the necessary removal of the existing roof structure, the vertical extension of the existing stairs and lift and an additional secondary stair. Information about the existing building was provided including the structural arrangement, element sizes and the loads that the building would originally have been designed for. This allowed candidates to make an assessment of the capacity of the existing structure and the impact of the proposed changes.

Candidates were required to consider the transition of the building from its existing condition to the new condition, including the removal of existing elements (roof), and the temporary stability of the building during structural alterations and temporary loading conditions. One of the key issues was the stability of the existing top-storey walls following the removal of the existing roof; these walls have a substantial height and would become freestanding once the restraint offered by the roof was removed. It was expected that candidates would identify this as a problem requiring a solution, then either look at the capacity of the structure to withstand these temporary loads conditions and suggest temporary works to prevent structural failure, or develop a methodology that removed the temporary risk.

The design of the new structure could have been developed using a number of different materials or methods, most of which would take support from the existing building, though it was possible to present a solution that transferred new loads entirely through the building to new foundations. A requirement was for the candidate to demonstrate that the existing building could support these loads and to look at how the new construction could be connected to the existing to suitably transfer vertical and horizontal loads down to ground.

The proposed solutions should have sought to make use of the existing building fabric where possible, to provide a solution that made efficient use of materials, recognizing that reuse and adaptation of existing buildings is more sustainable than demolition and new construction; building reuse is commonplace in the construction industry and will become more so in years to come. Candidates were asked to challenge the brief to find further material efficiency, with a number of solutions possible including removal of roof overhangs, reduction in extension size, further investigation to demonstrate that more existing materials could be used, or layout changes to avoid a transfer structure and/or remove the need for temporary works.

Unfortunately, the question was poorly attempted, with only a small number of candidates having the confidence to attempt a question involving an existing building. Candidates generally failed to recognize the process that the building needed to go through from its existing condition to the completion of the works in order to ensure it remained stable at all times. Most candidates also failed to consider the capacity of the existing structure to support the proposed changes in terms of vertical and horizontal loading, and didn't provide simple load comparison calculations.

Most solutions involved supporting a lightweight extension on the existing structure though many struggled to find two distinct and viable solutions. The second solution generally involved installing new structure through the full height of the existing building e.g. load bearing masonry walls, though some candidates designed these only to support the new loads without recognizing that the structure they were installing would inevitably also provide support to the existing structure. Some proposed solutions were very heavy in their material use which was in conflict with the intent of providing an efficient and sustainable development. Section 2 asked candidates to develop their chosen solution including calculations, drawings and methodology. Calculations were generally produced to an acceptable level, though little was provided in terms of connections e.g. between new and existing construction.

Drawings were generally poorly presented and there was a lack of critical details. When making changes to an existing building there must be clear understanding of the existing condition, what must be added or taken away and how different materials and methods of construction interact with each other. Drawings failed to expand on the provision of temporary stability.

Method statements were brief and failed to demonstrate that clear thread between existing and new condition, though time constraints at the end of the exam often mean that this part of the question is poorly answered. Good commentary was provided on safe construction and temporary requirements such as scaffolding or material handling, though not specific to this particular building.

Overall it was disappointing that more candidates did not attempt the question and from those that did there appeared to be a lack of experience in working with existing buildings and understanding the approach required. Candidates for similar future questions should look to demonstrate the transition between the existing and proposed conditions including temporary instabilities, the change in loads and load paths, the capacity of the existing structure, the interaction between existing and new structure in terms of physical connectivity and the transfer of loads, and the re-use of existing elements where these can be demonstrated to have the capacity to support the alterations.

Examination Statistics

The following section provides some general statistics to provide an overview of candidate performance during the exam. A total of 388 candidates attempted the exam.

Pass rates by question

Question	Pass rate
1: University teaching hub	20.46%
2: Multi-storey residential/student accommodation development	14.71%
3: New Coastal path cycleway and pedestrian bridge	21.43%
4: Industrial building with overhead cranes	50%
5: Existing warehouse building	28.57%
Total	27.57%

Pass rates by exam attempt

Exam attempt	Pass rate
1st Attempt	41.77%
2nd Attempt	31.65%
3rd Attempt	18.99%
4th Attempt +	7.59%

This table does not include the total number of candidates in each attempt number, only those that passed.