Chartered Membership (Part 3) and Associate-Membership Examinations, April 2002

The examiners' reports are to be read with reference to the April 2002 question paper available from the Institution at £3.00 for members and £4.00 for non-members.

Chartered Membership (Part 3) report

This year's examination was attempted by a total of 913 candidates, which was a decrease of 66 compared to last year. Of those candidates 475 took the examination in the UK while there were 438 candidates in International centres, of whom 323 sat at the two Hong Kong centres.

- The UK pass-rate was 37.5% a decrease of 6.2% compared to last year. There were 178 successful candidates.
- The International pass-rate was very disappointing: 65 passed from 438 candidates achieving a pass-rate of 15.5%, the lowest on record.
- At the Hong Kong centres there were only 48 successful candidates achieving a pass-rate of 14.8%.
- The overall Pass-rate was 26.6% the lowest for many years.
- The Cass Hayward examination prize was awarded for a solution to the bridge question.

The Examinations Panel, which includes the Examination Advisers and Chief Examiners, continues to review all matters concerning the Chartered Membership (Part 3) and Associate-Membership examinations.

The examiners continue to be

Question 1

The question called for the design of a three-storey Science Building 45m long by 21m wide with a curved roof. Internal columns were limited to one column at ground floor level and a line of columns at first floor level. To comply with the requirement of only one column at ground floor level, it was expected that the candidates would elect to use the line of columns at first floor level on a partition line to form a transfer structure. This could have been in the form of a truss (subject to consideration given to door openings in the partition) or a vierendeel girder. The external elevations were to incorporate a minimum height of 1.5m of glazing per storey, which was not to be obstructed by structural members other than columns. To comply with this candidates were expected to use moment stability frames in the elevations in lieu of bracing.

The site was sloping across the width of the building with the new ground floor level being 0.3m above the level of the higher part of the site. The ground conditions consisted of 0.75m-1.0m of loose fill on top of a tapering layer of soft to firm clay varying in thickness from zero on the lower part to 3m on the higher part of the site, with stiff clays below. Ground water was encountered at 3.5m below ground level. The ground conditions were such that both traditional pad foundations (of varying depth across site) and piling, taken into the stiff clays, were viable solutions. These conditions were chosen to test the candidate's ability to choose the most economic foundation solution together with consideration given to health and safety issues.

After construction was complete the client asked whether a basement storey could have been constructed beneath the whole of the building. This called for a major change with significant structural implications and candidates were expected to recognise this and give full consideration to the constructed structure in their proposals.

Although there were a number of aspects to this question which required careful thought it should have posed few problems to competent candidates. On the whole the quality of the answers was very disappointing. A large number of failures were due to non-compliance with the client's brief; the majority of candidates misinterpreted the question and provided a line of internal columns at ground floor or used load-bearing masonry or concrete partitions, transforming a challenging question into a simple one.

Some candidates also proposed hanging the floors from the roof. The wording of the question did not clearly prohibit this and these candidates were not penalised providing the number of columns used did not over compromise the space at second floor level.

Very few of the candidates who interpreted the client's brief correctly proposed the use of a vierendeel or a truss as the transfer structure. Candidates also found it difficult to propose two solutions that reflected a change in either vertical and/or lateral load transfer.

Most candidates understood the implications of the ground conditions opting generally for piled foundations and a suspended ground floor slab. One candidate who opted for pad foundations did not recognise that the ground water did not affect the allowable bearing capacity of the clays resulting in uneconomic pad foundation sizes being proposed.

Others who opted for pad foundations failed in the letter to explain how the basement could be constructed without disturbing the foundations. Most candidates however, grasped the difficulties of constructing a basement under a building already built. In part 2c) some of the candidates who proposed a vierendeel as the transfer structure calculated the moments acting incorrectly resulting on the use of inadequate section sizes.

The drawings and details were generally not well presented and were lacking in the information required to be sufficient for estimating purposes.

The method statement was often little more than a list of activities and did not address the safe erection of the building. Programmed time periods given for each activity were rarely realistic.

Question 2

This question involved the design of a 124m long by 82m wide 'tall' single storey distribution warehouse for frozen foods, with an imposed ground floor loading of 50 kN/m^2. The warehouse was to be designed for flow-through of goods, with 30 loading docks on each side of the building and a two storey goods in/goods out office located centrally in these elevations. A maximum of five internal columns was permitted in the warehouse and a minimum column spacing was given for the external walls. Ground conditions comprised 2-3m of firm-stiff clay over 0-2m of highly compressive organic material sitting on top of a tapering layer of very soft silty clay and weathered mudstone/mudstone, with groundwater encountered at 2.0m below ground level. On completion of foundation construction, the Client decided to reduce the number of internal columns to a maximum of three (excluding any in the offices).

The question was relatively straightforward, provided the candidate took on board all aspects of the Client's brief and considered the full implications of the buildings size, and in particular height, and the relatively high roof (1.5kN/m^2) and ground floor loadings.

The question sought to test the candidates' ability to take a brief and rationalise it by selecting the best geometry to accommodate both the number of loading docks required and the minimum column spacing stipulated, but many papers showed an inability to deal with this properly, with several failing to provide the required number of docks and one candidate even choosing to make the building longer. The candidate also needed to consider the implications of the layer of organic material on both foundation and ground floor slab construction, and the horizontal deflection of the building eaves, given its height and the presence of the two-storey offices at mid-elevation.

Fewer candidates attempted the question this year, but, on the whole, the quality of the answers could have been better. Most candidates chose either a trussed or portalised solution, with the five central columns supporting a primary truss/girder and secondaries spanning to the external walls. As is all too often the case, many candidates offered 'variations on a theme' rather than two distinct solutions for Part 1(a), or only paid brief lip service to their second solution. Far too little consideration was given in many solutions to the effects of horizontal deflection and the stability of the building was also doubtful in several instances. A number of candidates considered the use of cantilever columns to resist wind loads, but most failed to mention the associated issue of sway stability or to consider the impact on the piled foundations. The inclusion of diagonal bracing in the loading docks was also not uncommon.

Most candidates adopted piled foundations, but several opted for a ground bearing floor slab, some proposing to vibro-compact the organic material, whilst some chose to excavate this material in its entirety (up to 5m down, with groundwater at –2.0m) and to replace it with granular fill. One candidate stated that the 50kN/m^2 floor loading was too high for a suspended slab and the settlement would be designed out (it wasn't subsequently mentioned in the detailed design). A few simply ignored the variable ground conditions.

The letter in 1(b) was generally poorly presented, although most successful candidates dealt with it well. Many recognised the need to redesign the steelwork, and, to varying degrees the effect this would have on the steelwork order, but some appeared to fail to consider the likelihood that the fact that the foundations were complete would imply that steelwork was probably almost ready for delivery and assumed that they could simply modify the design with minimal cost. The impact on the foundations was also poorly dealt with by some candidates, with one stating that they would probably be satisfactory for the (40%) increase in load and the change should only have very slight programme implications!

Question 3

The question asked the candidates to design a bridge across a moat to a historic fortification. The ground conditions were fill over chalk bedrock. The location of the supports was restricted at the east end with a requirement not to impose any load on the wall or fill within the fortification. A 3m clearance in front of the fortification was stipulated and the intention was that candidates designed a cantilevered deck at the east end. Part B of the question involved an archeological find at the west abutment.

The question was challenging but gave candidates an opportunity to show their knowledge of some fundamental principles of bridge design and construction. Candidates who demonstrated knowledge of the effects of torsion and articulation problems of curved decks were rewarded. Mention of issues such as deflection and vibration of the cantilevered deck obtained extra marks.

Part 1(a): In general the discussion of load transfer was poor. A great variety of structural forms were proposed, some less suitable for the curved alignment. Elegant solutions, however, achieved additional marks. Span arrangements varied from one to four. Several candidates simplified the question by placing a support inside the fortification. This solution was only accepted if the design strictly complied with the requirements in the question. Many candidates failed on this point because the construction of the foundation caused loading to the fill inside the fortification, or they did not adequately explain how it could be constructed while maintaining stability of the historic walls. A significant number failed because they did not appreciate that a simply supported curved structure is not stable without torsional restraint at the support.

Candidates often did not give much attention to the requirement not to load the fill on the east side. Acceptable foundations were piles into the bedrock or pad foundations in the chalk. Consideration of how these would be constructed without disturbing the fill or historic structure was often omitted. Those who designed massive cantilevered abutments or placed a support inside the fortification usually failed to explain adequately how this complied with the brief. Many scripts failed to provide sufficiently distinctive alternative schemes or authoritative arguments to justify their preferred solution.

- Part 1(b) was generally disappointing with candidates stating the obvious. There was ample opportunity to discuss issues on revised vertical/horizontal alignment and the effect of the works on the remains and increased torsion.
- Part 2(c) The calculations were often comprehensive for the superstructure but often candidates were not as competent on the foundations. Several failed to identify the critical elements to the proposed structure.
- Part 2(d) The quality of the drawing was variable with most not providing sufficient information for estimating. Good clear drawings are essential to convey design information. A few candidates gave their name in this section, against advice.
- Part 2(e) The details were of a standard form but many did not adequately describe how access would be provided for repair and maintenance as required in the brief.
- Part 2(f) The method statement was usually in a sequential list form with little specific reference to the site constraints. The question provided ample opportunity to discuss issues such as construction in/over water, construction adjacent to sensitive buildings in loose fill and in an environmentally significant location. Those candidates who designed massive construction or supports at the east end failed to explain how they would avoid damage to the historic fort during construction.

concerned about a number of aspects and make no apologies for reiterating the comments that have been made over the past couple of years. The introduction of computer aided draughting has greatly reduced the ability of many to produce even simple drawings. Similarly, the increasing use of design programmes has meant that many candidates seem to have little opportunity to develop engineering judgment. Last year saw an alarming introduction of the use of flowcharts that showed in pictorial fashion how the loads were transferred through a building and into the foundations. Sadly this year the trend has continued which calls into question the basic ability of some of the candidates who attempt the examinations. The use of stick-on notes to form a number of specification clauses both on the sketches and in the answer book was again noted.

Despite asking candidates to confine themselves to technical issues when writing letters about engineering problems, many still invent obstacles that are not part of the question and then use these as reasons why a client request to change something cannot be achieved.

Drawn information was generally below expected standards, leaving examiners wondering how some candidates are able to communicate ideas and design to CAD technicians even in the relative calm of the design office environment. Candidates are required to have a working knowledge of building construction. Many sketches lacked even basic references to floor finishes, damp proof courses, roof finishes, cladding, gutters etc.

The method statements were generally very poor. Many were little more than a list of activities ignoring aspects of safe construction, a serious concern given the increasing emphasis on the designer's role in health and safely matters. The programmes were similarly lacking and often showed a lack of appreciation of the time required for operations to be completed.

Those responsible for training and sponsoring candidates could do a great deal more in helping to lift the general standard of those who do have the ability to pass this examination.

In summary candidates (with the help their sponsors) who wish to approach this examination seriously would do well to concentrate on the following:

- Obtain a good grounding of conceptual engineering design;
- Make sure that you obtain all round experience in engineering design, drawing, and problem solving;
- Prepare thoroughly and enlist the help of your sponsors in considering past papers. Recognise that courses, whilst providing valuable tuition, do not by any means fulfil all of the training necessary to become a chartered structural engineer.
- Concentrate on real issues; flow charts and stick on notes do not demonstrate competence.

Pass-rate for questions

- Question 1 (New Science Building) was attempted by 200 candidates, of whom 31 passed, a pass-rate of 15.5%.
- Question 2 (Distribution Warehouse) was attempted by 133 candidates, of whom 45 passed, a pass-rate of 33.8%.
- Question 3 (Access Bridge) was attempted by 91 candidates, of whom 22 passed, a pass-rate of 24.2%.

Question 4

Candidates were asked to design a school hall extension by adding two floors on top of it; this was a test of the design of a beam/column frame structure under restricted environment with the following issues to be observed:

- the existing hall was to remain operational during the construction of the extension;
- no structure, either permanent or temporary, was permitted to rest on the existing building;
- no loading of any type, permanent or temporary, was permitted on any part of the existing building.

The question was straightforward; however, it was generally not tackled well. The alternative scheme proposed by most candidates was very similar to and not distinct from their recommended scheme. Too few candidates appreciated the space above the roof for truss/hanging systems, though that might have affected the idea of a rooftop playground.

Most solutions did observe the restriction of not placing reliance on any part of the existing hall for temporary or permanent support. However, many solutions adopted an *in situ* construction that would make continuous operation of the existing school hall difficult as well as hazardous without very careful planning/method statements, which most candidates failed to address.

A considerable number of candidates put forward solutions with no preliminary scheme calculations to see that they were viable, often resulting in unworkable calculations in part 2 of the question. Few candidates carried out an outline check of loading to establish approximate ground bearing pressures at the depth of dense sand and gravel.

A significant number of candidates ignored the client's functional requirement. Whilst the scheme was structurally safe, the grids adopted would result in columns inside the classrooms, impractical corridor arrangements, and inaccessible classrooms. Many candidates showed inadequate consideration of buildability. They failed to look at the overall size of the proposed extension and to divide the two floors into 16 classroom areas with corridor access to these. The classroom layouts were often not indicated resulting in the partition loads not being taken into consideration in the calculations. There was often a lack of thought about location of new foundations, i.e. between existing foundations, close to the existing line to reduce span but not too close resulting in new foundations going underneath the existing hall.

Elemental calculations were generally good. Candidates tended to be weak, however, in outline scheme design calculations for the project in overall concept. Most presentations showed the candidates had no feel for size – with massive slabs and beams and columns being proposed, as well as enormously long piles.

Method statements were, in general, poorly done. Most candidates treated this as a risk assessment rather than a proper detailed consideration of the method of safely constructing the new structure.

The poor performance of the candidates was probably due to general lack of overall technical and practical experience, as opposed to elemental design experience, coupled with a lack of examination technique and time management.

Question 5

Candidates were asked to design a 6-storey boathouse including a partial basement on a marshland site flooded at high tide. The following issues needed to be addressed:

- land reclamation, and how it was to be achieved;
- wind loading: the stair/lift shafts were not adequate alone to resist wind loads on the side of the building, given their location relative to the shear centre of the building;
- buoyancy of the basement, particularly during construction when its weight would be at a minimum, and given that the ground conditions would allow a free percolation of water from the river;
- lateral stability of the building, with the constraint that no internal columns were permitted between 1st and 2nd floors.

Most successful candidates explored two basic alternative structural forms: a portal frame with the primary cross-beam at 2nd floor level, and a multi-storey portal with frame action at each floor. Candidates who proposed frames at 4m centres or less found it easier than those recommending wider spacings. Piled foundations were straightforward and appropriate. A few candidates offered alternatives such as tension structures with the upper floors supported from roof trusses or cable-stayed external structures, and where these solutions worked they were excellent. These candidates should be congratulated for their confidence and ability to put forward unusual yet satisfactory solutions under exam conditions.

Unfortunately, far too many other candidates appeared to be unable to meet the challenges of the question.

The building had 6 storeys. It was hoped that candidates would at least mention the words 'progressive collapse' or 'robustness' at some point in their scripts with an indication as to the consequences for the structural design. Only a minority did so.

Typically, wind loading was dismissed by many candidates as being fully resisted by the stair/lift shafts, which then allowed them to ignore the lateral stability of the building. This should never be assumed without at least a brief outline calculation to check the validity of the assumption: in this case the assumption was not justified.

Many candidates were able to offer only beam-and-slab and flat-slab construction as two distinct solutions, without explanation as to why either of these would be appropriate. In the context of the question, these minor differences were irrelevant and gained few marks.

Many candidates did not appreciate that buoyancy would be a problem that would impair the stability of the whole building, although they designed basement walls to resist lateral water pressure and, in some cases, basement floor slabs to resist the upward pressure.

It appears that many candidates have learnt a set of generalised phrases, possibly during exam preparation courses, to describe the transmittal of vertical and lateral forces to the foundations which they offer in response to the 'load transfer' item in part 1(a). Occasionally these descriptions apply to the question at hand, but often they do not and candidates will not gain marks for irrelevant and inaccurate information. The impression created by the indiscriminate use of these descriptions is of a candidate who is unable to think clearly. Candidates are penalising themselves by spending valuable time regurgitating these descriptions, where a relevant annotated diagram would be far more effective in demonstrating structural understanding.

Some candidates agonised over the need for a major movement joint across the building. It was not considered to be an essential item but, if provided, it was necessary for each portion of the building to be independently stable. Where a candidate had previously relied on the stair/lift shafts for stability, this presented a problem which was almost always ignored.

In part 1(b) it was hoped that candidates might mention the threefold increase in buoyancy generated if the basement were to be enlarged and the need to provide measures to resist it, coupled with the beneficial effect of the centre of uplift coinciding more closely with the building's centre of gravity. Popular responses included the commercial value of the enlarged space, a need for extra waterproofing as the basement would be closer to the river, and the need to charge increased fees because of the extra design work. Regrettably, most candidates missed the point.

The quality of many calculations and drawings was low. The detailing of the balcony required in part 2e(i) often omitted the method of tying it back into the main structure. Many method statements offered in part 2(f) could have been for any building anywhere and ignored the specific requirements of the question.

Question 6

The question was based on the construction of a new visitor centre in an area of wetlands and offered an opportunity for candidates to show how a simple structure could be engineered within the set constraints. Candidates were expected to take account of the countryside location, poor ground conditions and fluctuations in groundwater levels. Additional marks were available for suitable designs for the access bridge and walkway decks.

Framed structures with braced beam and column elements supporting concrete and/or timber floors, supported by reinforced concrete spread footings were considered appropriate. A timber framed building with a grass roof was a viable alternative and most sympathetic to the countryside setting.

Most candidates chose steel framed structures with portalised bracing and precast floors. Foundation solutions were often heavy, with piling in abundance.

Discussions for the choice of final scheme were not presented adequately by many candidates. Evidence of a clear thought process is required to pick up maximum marks in Part 1a. It was noted that unnecessary time was wasted here by the use of longhand descriptions of loadpaths rather than more succinct use of sketches, leaving more time to describe the significant aspects of the alternative schemes.

The groundwater problem was not discussed well and frequently not mentioned at all. The Client preference for a grass roof covering was sometimes rejected without adequate reason. The weight of such a roof was sometimes grossly underestimated and 'grass' was misread as 'glass' on more than one occasion!

Part F was poorly attempted, possibly reflecting the inexperience of candidates in respect of construction programming and safety issues. Answers to this final part of the paper appeared rushed, demonstrating poor time management on the part of some candidates.

Question 7

The question asked candidates to design a steel platform deck structure (56m × 40m in plan), to transfer load from the six modules above into the three legs of the substructure below. The deck was supported by barges during mating with the substructure and the modules were then installed by floating crane. The deck was thus a deep grillage in which several of the frames sag while supported by the barges but hog when supported by the substructure.

Several candidates positioned one of the barges between gridlines 1 and 2, thus not fully complying with the requirements of the question. In addition, some candidates considered blast loading although the question stated that blast loading should not be considered.

Two distinct and viable solutions comprise a grillage of trusses and (due to blast loading not requiring consideration) a grillage of orthogonally stiffened plate girders. These two solutions were proposed by most candidates although there was generally less understanding of the design of the stiffened plate option.

Several of the candidates failed to produce two viable solutions with some showing a poor understanding of load paths and others not fully considering the temporary conditions of load-out and mating. Several scripts had insufficient calculations and did not establish the sizing of principal structural components. Very few of the candidates' sketches of the connection point details and support point details were viable and capable of transferring the significant loads into and out of the deck.

Most candidates allocated their time appropriately to each part of the question although, as in previous years, some candidates did not allow sufficient time to complete questions 2e and 2f.

- Question 4 (School Hall Extension) was attempted by 119 candidates, of whom 39 passed, a pass-rate of 32.8%.
- Question 5 (Boathouse) was attempted by 324 candidates, of whom 83 passed, a pass-rate of 25.6%.
- Question 6 (Visitors' Centre) was attempted by 36 candidates, of whom 20 passed, a pass-rate of 55.6%.
- Question 7 (Platform deck Structure) was attempted by 10 candidates, of whom 3 passed, a pass-rate of 30.0%.

Associate-Membership Report

30 candidates attempted the written examination this year, the lowest number of candidates on record. This total included eight international candidates, seven from the Republic of Ireland and one from Cameroon. This year's overall pass-rate was 46.6% very much down on last year's rate of 63.6%.

The format of the examination was unchanged and required candidates to answer one question from a choice of four. This was the fourth year that a bridge question has been included and the question was attempted. Eight candidates answered the structural steel question, 12 answered the reinforced concrete question whilst nine candidates attempted the general construction question. The Denis Matthews prize was not awarded this year.

Structural steelwork

This question showed the layout of a twin 30m span portal framed building with internal offices constructed to meet a client's specific requirement. In this instance, the bending moment information was provided as well as the usual design data. In Part A candidates were required to determine suitable member sizes for the main external and central portal stanchions together with its portal rafter member, along with suitable sizes for the roof bracing members, the vertical bracing and a gable stanchion. Calculations were required for the bolted connection details at both the haunch and apex. Candidates were asked to provide fully annotated and dimensioned details for the vertical bracing to the portal stanchion, specific horizontal bracing members with the portal rafter, and the connection between a particular rafter and stanchion. In Part B candidates were asked to give a sketch outline of the proposed structure for the office area, which was to be a steel frame with precast concrete floors; to sketch a suitable partition structure to achieve a 2-hour fire separation as the client wished to sub-divide the building after it had been constructed, and to give a typical base plate to foundation detail. The steelwork quantities for the building, set out in a Bill of Quantities format, was also required, and candidates were asked to outline two alternative paint protection systems and two methods to check the integrity of suspect welds.

Generally the design aspects were adequate and the calculations for the portal connections were satisfactory in most cases. The bi-axial bending in beam D was not appreciated by many of the candidates who omitted the horizontal loading. The drawing details required were generally adequate with sufficient detail included. Those candidates who failed showed weakness in practical structural design with insufficient work produced to the required standard.

In Part B(i), although the question did not specifically ask for calculations, the base plate did need to be sized, in order to provide sufficient detail information. In many cases the design of foundation K did not allow for the horizontal loading. Some candidates produced a good BoQ, the remainder just produced a schedule of weights. In question B(iii) most candidates provided a satisfactory detail for the partition structure, but only a few considered the need for additional foundations or a sliding top joint. Whilst in B(iv) two suitable alternative paint systems were given, the surface preparation to the steelwork needed was often not considered. Similarly, most candidates were able to provide two different methods for checking the welds; however it should be noted that a system using radiology would not be suitable on site.

Reinforced concrete

The subject of this question was a 25m circular view and display building to be built at the end of a rocky seaside peninsula, access being along the peninsula itself from the nearby town. The peninsula was surrounded on three sides by deep tidal seawater. A steel superstructure above the concrete was to be ignored by the candidates except for wind effects and the holding down bolts, for which the details were given.

In Part A the candidates were asked to determine the reinforcement for the base slab, the circular wall, the concrete walkway slab and its associated cantilever supports and to design and prepare sketches for the flights of stairs spanning between the walkway and the display area floor. The reinforcement detail for the structure was to be drawn to a suitable scale; the bending schedule and weight of reinforcement for the structure was also to be provided by the candidate. In Part B candidates were asked to provide a method statement for the construction of the whole reinforced concrete structure together with suitable annotated sketches, bearing in mind the dangers of deep tidal seawater. Candidates were also asked to write instructions to the contractor on how the existing bedrock surface was to be prepared and levelled before waterproofing and casting the reinforced concrete floor. Sketches were also required showing the position and details of all 'daywork' joints and how the dry stone walling was to be tied-back to the concrete drum structure.

The rc design was well attempted by those candidates who passed. Those that failed did so because they omitted to design all the required elements, spending too much time on minor design detail. The drawings were either good or very poor and lacking in essential detail. It generally followed that a good drawing would give a good bending schedule and vice versa. In question A(iv), candidates with time to attempt this question provided satisfactory design calculations and sketches; otherwise answers were very sketchy with no calculations given, indicating a lack of time.

In Part B candidates either did not use sketches and attempted to explain the answer through written detailed paragraphs, or produced highly detailed sketches for parts of the answer with the written part barely discussed. Some candidates ignored the problems of working near tidal sea water. In B(ii) a few candidates misunderstood the meaning of the term 'dry stone wall', whilst other candidates specified unsuitable materials for a sea air environment. The instructions to the contractor were very imprecise; some candidates made no mention of soft or fissured rock being removed. In B(iv) most candidates provided details of a daywork' joint either for the slab or for the wall, but not for all the structure as required in the question; very few candidates indicated the positions for these joints.

Generally, the answers for Part B indicated that some candidates have little or no site experience and this was reflected in the low marks awarded. Candidates needed to pass both parts A and B to satisfy the examiners.

General construction

This question concerned the construction of an octagonal shaped visitor facility, which was to have a proprietary waterproof membrane system laid on plywood decking supported by timber rafters and purlins. The overall roof structure being supported by a steel column and beam framework designed to receive a glazed lantern provided by a specialist supplier. The building was to have a clear width of 20m, and be founded upon very stiff clay.

As with other questions, Part A dealt with design and detailing while Part B tested the candidate's site construction knowledge, including the method statement for the safe erection of the steel framing and a specification for the protection of the exposed steelwork against corrosion and the appropriate fire resistance.

This was a difficult question. Few candidates were able to recognise the way in which the perimeter could act as a 'ring beam' and the structural analysis required for such a beam. The low marks obtained in Part A were directly associated with the lack of structural analysis to address this problem. Part A (i)(a) asked for the steelwork column and roof beam/ring beam to be designed. However, the plan did not identify directly the perimeter beam as the ring beam and this confused some candidates, as a circular beam was also inferred to support the roof lantern.

Those candidates that failed did not use the appropriate information given in the question, lacked ability to design in the various materials, or spent too much time on the design and too little time preparing the drawings.

In Part B some candidates scored good marks by producing well thought out answers with neat sketches; others showed a lack of experience in site work. Most candidates produced satisfactory construction details requested in Question B(iv). It was interesting to observe that where the 'erection procedures' and 'health and safety' points were tested the response was very good; this perhaps reflects the increase in knowledge about health and safety requirements.

Bridge construction

This question showed a two 16m span reinforced concrete aqueduct, which was to carry water across an existing road. With the availability of local traffic diversions it was acceptable to close the road to allow construction of the new structure. Candidates did not need to consider details of the water retention aspects, or the abutments, or the joints between the abutments and aqueduct deck; also the handrail details were to be ignored.

In Part A candidates were asked to determine suitable sizes and the reinforcement for the base slab of the aqueduct, the main side beams, and the central pier with its foundation base, to provide to a suitable scale, a drawing showing a plan, section and elevation of the aqueduct. All principal dimensions were to be included. A bending schedule was to be prepared for the pier base and stem along with sketch details for the bearings at the top of the pier, and for the connection between the base slab of the aqueduct and its side beams including the reinforcement details. In Part B candidates were asked to describe with the aid of sketches the safe method of construction of the aqueduct, to determine the quantities for the structural elements of the aqueduct (in a Bill of Quantities format), and to discuss and illustrate with sketches the articulation arrangements for the aqueduct deck. Having completed the design, the Highway Authority decided that it was no longer acceptable to close the existing road to allow construction of the aqueduct. Candidates were asked to prepare a letter to the Client setting out alternative methods of construction and how this would affect the design.

In general Part A was well attempted, although in the design of the pier and base, the effect of any collision impact loading was not considered, despite the location of the aqueduct being across an existing road. Candidates had difficulty with Part B. The safe method of construction was answered using a list of items involved; no mention was made of the 'safe procedures' in carrying out these operations, as required In the question. No sketches were provided although these were asked for in the question. In Part B(iv) candidates didn't offer alternative designs and methods of construction such as precast, prestressed concrete or a design in steel that might have overcome the problem of road access. Obviously marks could not be awarded where the question was not attempted.

Associate-Membership oral examination

For a limited period this route will remain available to candidates not less than 35 years of age with the minimum academic qualifications and suitable experience. During the year there was one candidate via this route who was successful.