Examiners' Report 2008

The examiners' reports are to be read with reference to the April 2008 question paper available from the Institution at £3 for members and £4 for non-members

Chartered Membership Examination 2008

This year's examination was attempted by a total of 706 candidates, 15 more than last year, of which 388 took the examination in the UK and 318 throughout the rest of the world. The UK pass-rate was 36.7% and the overall Non-UK pass-rate was 31.0%. The Hong Kong candidates' pass-rate was 31.8% and other Non-UK centres' pass-rate was 29.1%. The overall pass-rate for 2008 was 36.7%, a slight decrease on last year.

The examiners draw future candidates' attention to themes which re-occur every year:

- Candidates should identify the crucial problems posed by their chosen question which must be solved for a successful outcome. They should communicate their understanding of these problems clearly, then address the problems in their proposed solution and not ignore them. They should produce calculations for the key elements and not spend too long on less important items.
- Candidates should avoid neglecting part 2(e) until near the end of the examination, when their work suffers from severe pressure of time. It is preferable to highlight matters of key importance in part 2(e) rather than prepare a list of activities, some of which are trivial.
- Candidates can lose marks by using pre-prepared or 'standard' answers if they are not relevant to the question. At best, such answers may help as a checklist of items to be considered. At worst they give the impression that a candidate has not understood the implications of the question and has not realised why the 'standard' answer is inappropriate.
- Presentation is important. If examiners cannot read what candidates have written or make sense of their diagrams, marks will be awarded more reluctantly than if the candidate's ideas were clearly and concisely expressed.

Question 1. Sports Arena

Candidates were asked to design a circular 80m-diameter sports arena. Minimum constraints were imposed to allow candidates great flexibility to arrive at solutions: the primary requirement was for uninterrupted viewing of the central arena. A long-span roof was needed, and most candidates opted for a conventional but heavy truss, spanning either radially or on a rectangular grid.

The radial solution offered greater economy both in reduced steel weight and ease of fabrication as all members were essentially the same. Consideration needed to be given to the complexity of the central node where there was potential for congestion. Candidates opting for a rectangular grid truss tended to design much heavier elements which were very inefficient in carrying the low imposed roof loads.

Some radical designs were proposed, such as cable-stayed roofs: interesting, but their structural action needs to be understood. It was important to resist the high axial forces in the girder that arose from the inclined stays, and to consider the axial stability of the tower and the need to transmit the axial force couple to the ground level. Candidates appreciating the effects of wind uplift scored additional marks, as did those considering temporary stability and the methods of construction.

A second important design element was the high perimeter wall. Most candidates recognized that the wall offered a good location for placing shear bracing, but few considered the question of how to transfer the wind force on the building satisfactorily. The use of roof plan bracing was not well covered. Stiff perimeter columns were structurally acceptable but were rather uneconomic and the stability of the columns in the wall in the out-of-plane direction was ignored by some. The stability of the masonry cladding stability also needed to be considered.

The internal structure was relatively simple and caused few difficulties. The foundations required piles around the perimeter, with similar treatment being also the most appropriate for the heavily loaded floor.

The letter (part 1b) expected candidates to recognise the effects of a large point force imposed on a structure designed for a low distributed load. The few proposing a straightforward solution of radial tension cables tied back to a compression ring at the top of the wall scored high marks while those who gave notice of extra fees without a full explanation of the structural issues lost marks. The quality of the letters suggested that few candidates have experience of writing to clients: they should seek the opportunity through their employers to practice writing formal letters.

The calculations were expected to provide the sizes of the primary load-carrying elements, with an estimate of deflections. A basic analysis of the distribution of forces was required using approximate methods, and the regularly-encountered statement that a computer package would be used if there was more time was unacceptable. Rudimentary check calculations suffice in the office to confirm computer analysis results; the same calculations are required in the exam.

Question 2. Waterfront Development

This question involved the construction of a new 4-storey riverfront residential development with a ground-floor restaurant. The entire building was to project out over the river and there was to be a wide terrace extending in front of the restaurant over the full length of the building. The front elevation of the building was to be fully-glazed, whilst the rear and side walls were to be clad in masonry. Limitations were stipulated on internal column positions and spacing.

Ground conditions comprised soft clay overlying mudstone. It was expected that candidates would consider both the ground conditions themselves and the problems of working within a tidal river when proposing foundation solutions.

Steel or concrete solutions for the building frame, and proposals involving combinations of both these materials together with others such as timber, gave some of the more elegant solutions. The most popular method of dealing with the change of structural grid between the restaurant and the apartments above was to use a transfer deck. Other acceptable solutions included: the introduction of a Vierendeel girder on the rear line of the apartments, spanning between the service cores, with a 'simple' transfer beam running the length of the building over the line of the ground floor columns to support the upper storey columns above; the introduction of a series of trusses at roof level from which to hang the residential floors; spanning the apartment floors clear from front to rear (12m), with the restaurant columns positioned under the rear wall of the apartments (the question limited only the spacing of the internal columns, not their position relative to the external walls/columns). Unfortunately, some candidates either misunderstood the question or chose to simplify it and aligned the structural grid throughout the building, thus contravening the brief.

Stability was, as always, a vital consideration in deriving the alternative solutions in Part 1(a). Good candidates recognised that, while the obvious methods of providing lateral stability to the structure were to use sway frames or bracing, the requirements for full-height glazing to the front elevation and balconies to the apartments made this difficult. Suggestions for overcoming the problem ranged from commenting on the need to ensure that the front elevation was stiff enough to avoid damage to the glazing, to proposing the inclusion of feature diagonal bracing; however, providing standard bracing to the glazed elevation without considering its impact on the aesthetics or functionality of the building (for example designing cross-bracing that made it virtually impossible to access to the apartment balconies) did not gain high marks.

The letter in Part 1(b) required candidates to consider a request to add a further two storeys of apartments to the development. Whilst most candidates recognised the impact that the additional loading would have on the design of the transfer structure, many disappointingly proposed a complete redesign. An encouraging number of candidates did think laterally about how the effects of the change could be minimised, and proposed the modification of the superstructure to use more lightweight construction such as pressed steel framing or a timber frame. The introduction of additional columns within the ground floor restaurant area was also proposed by some, as an acceptable compromise to accommodate the change of brief.

It was anticipated that the calculations in Part 2(c) would cover, as a minimum: the roof truss (if used to support the structure beneath); any transfer structure proposed; the primary floor beams in the apartments; the restaurant columns; the lateral stability of the building, whether it be a sway frame or bracing system; the restaurant and terrace floor slab and the foundations. Good candidates avoided the temptation to concentrate on the easier parts of the structure rather than designing the more complex elements.

In Part 2(d) candidates were required to decide which areas were critical, and to provide sketch details of them. The details varied, depending on the chosen solution, but it was expected that they would include: the connection between the Vierendeel girder and the primary floor beams, or, alternatively, of the transfer deck to the restaurant columns; the connection of the restaurant columns to the floor slab and foundations beneath; the floor beam/balcony beam/glazing interface. Some candidates prepared clear and concise drawings that conveyed all the necessary information, with sufficient detail and dimensions, and scored high marks.

The most important matter for the safe construction of the building and the construction programme in Part 2(e) was the need to build over water. Some candidates either ignored this aspect, or chose uneconomically to provide a cofferdam around the entire building footprint and construct in the dry. Good proposals considered how the effects could be minimised, for example using precast concrete construction for the pile-caps and either precast concrete or steel permanent shuttering for an *in situ* concrete deck. Some also considered how the piles might be installed (e.g. jack-up barge), although it is appreciated that few candidates would have had specific experience of this environment and a simple common-sense approach was considered satisfactory.

Question 3. Road Bridge

The question called for the design of a road bridge carrying two traffic lanes and a footpath over a stormwater drain and cycle track. There were limitations on the positions of temporary and permanent works, on the headroom required and on temporary closure of the cycle track.

The ground conditions were suitable for piled foundations. The asymmetric transverse layout suggested the use of portal frame supports with equal double-cantilever arms to support the deck structure. Some candidates proposed a solid wall the width of the deck but this solution would seldom be used in practice because of its massive appearance.

There was a variety of feasible solutions for the longitudinal structural layout, including simply-supported beams or continuous beams/trusses on vertical supports, and a conventional beam/slab solution as adopted by many candidates was satisfactory. An arch structure or framed structure with either vertical or inclined legs would add visual interest. Some candidates proposed large trusses without lateral overhead bracings, but which when the U-frame action was checked, was often found to be unstable.

For materials, steel, concrete and steel/concrete composite construction were viable options, but proposing two options with the same span configuration but different materials was not considered adequately distinct: the spans would need to take account of the particular characteristics of the different materials. Although a few candidates proposed cable-stayed solutions it is unlikely that they would be economic in the situation. The constraints imposed by the position of the cycle track and the restriction on the working hours near it would make precast or prefabricated construction more attractive.

The additional wind loading that the addition of a noise barrier (part 1b) would have on the structure was appreciated by many candidates but the potential effects on the deck bearings were mostly ignored.

Candidates were expected to provide calculations for the principal structural elements: the deck slab and beams, the columns, abutments, pile caps and piles. Most calculations offered for the superstructure were adequate but those for the substructure were insufficient, probably because of poor time management. Although the quality of general arrangement drawings offered was generally satisfactory, the amount of information provided was often not sufficient for estimating purposes.

The key issues expected to be covered in part 2e were: a description of temporary works, how to achieve safe construction over water and above the cycle track, and how to create foundations under water.

Question 4. Exhibition Hall

Candidates were asked to design a four-storey exhibition hall. All floors were octagonal in plan and the upper two storeys projected out beyond the lower two storeys by 8m. There was a central atrium throughout the upper levels and the position of internal columns was restricted. An existing culvert ran underneath the building.

The building was not straightforward to visualise and it required candidates to understand the three-dimensional layout when proposing structural options. Viable solutions offered by successful candidates included:

- cantilever beams on each floor and the roof of the overhanging parts of the building;
- a load transfer cantilever structure on level 3 to support the columns at the overhang ing corners;
- a roof truss supporting hanger columns.

Good candidates appreciated that it was necessary to avoid any load surcharging the existing culvert. Suitable foundations would be deep piles with pile caps bridging over the culvert. It was also necessary to bridge the level-1 doorways to support corner columns above. Some candidates provided two distinct schemes but the capabilities of the two structural systems had not been satisfactorily exploited.

In the letter to the client (part 1b), candidates were expected to appreciate the need to provide long-span beams to support level 4 and the roof if internal columns were to be avoided. Most candidates were able to address the key issues but some did not consider the stability of the supports at the overhanging corners and proposed a solution with unstable cantilever beams.

In section 2(c), candidates frequently provided the typical design of a slab, a beam section and a column but omitted the essential but more complex elements such as hangers and transfer structures. A few drawings were well presented with plans and details adequate to communicate the design, and these gained high marks. Some candidates squeezed several levels on to a single plan and produced confusing details.

In section 2(e), it was expected that the candidates would cover the more unusual construction issues on the overhanging upper floors, particularly the large span cantilevers and any hanging columns. Those who did gained high marks. Those who produced merely a general list of concrete construction activities did not.

Question 5. Crocodile tank

This question required the design of a tank to accommodate crocodiles. An observation tower and three islands were to be provided in the tank and pedestrian access was to be provided from the perimeter of the pond to the observation tower. Restrictions were placed on the area of the tank and islands, but candidates were free to choose the layout; they were also free to select the form of the tower as long as it provided platforms of the required height and area.

The tank and its islands could be regular or irregular in shape as long as they complied with the requirements of the client's brief, but it was hoped that candidates would provide different shaped tanks for each of the two schemes proposed in part 1a. The tank was required to be of concrete construction. It was anticipated that the islands would also be concrete, but several materials or combinations of materials could have been used for the observation tower and access structures. It was expected that candidates would provide footbridges from the perimeter of the tank to the observation tower, possibly using islands as intermediate supports to reduce spans; however, tunnels would also have been acceptable. Bridges could be supported from the islands, from the tank perimeter and from the observation tower. Although the allowable bearing capacity of the ground at shallow depth was fairly low, the loads imposed by the tank were also relatively low and the tank should have been capable of being supported in the upper sand layer. The high water table meant that candidates needed to consider flotation.

It had been hoped that the limited number of restrictions imposed in the brief would have been seen by some candidates as an opportunity to exercise their creativity and develop imaginative solutions to the problem: some did and gained high marks, but disappointingly most chose to concentrate on function at the expense of form. Surprisingly, many struggled to come up with significantly different schemes in part 1a. Some chose to concentrate on one or two elements of the solution, i.e. the tank, the tower or the bridge, and provided rushed and sketchy solutions for the remaining elements. The majority of candidates sensibly adopted some kind of raft-type tank base, although a few provided over-complicated solutions involving combinations of piled and shallow foundations. Most candidates recognised the possibility of uplift due to the high water table and generally dealt with it by ensuring that the tank was heavy enough to counteract the upward force, although some chose to raise the level of the tank and the ground around it so that the ground water ceased to be a problem: this was satisfactory. The structural design of the tank was carried out reasonably well but the durability aspects were less well understood and often inadequate attention was given to crack control reinforcement, waterproofing and jointing etc. Observation towers and bridges were typically steel framed, cross-braced structures and were generally competently, if unimaginatively, designed.

Candidates were required to write to the client explaining how they proposed to deal with the problem of low-strength results for concrete cube tests. Candidates were expected to consider the implications of the low strengths on the base and walls of the tank, indicate whether further testing (or interrogation of the test results) may have been appropriate, and suggest possible solutions for remedial works. Letters were generally well-written with most candidates understanding the implications of the low test results on the strength of the tank; good candidates also addressed the durability aspects.

In Sections 2c and 2d calculations and drawings were expected for the tank, the main members of the observation tower and the main members of the pedestrian access structure. The method statement in Section 2e should have addressed the particular aspects of the selected scheme and was expected to include mention of dewatering, tank joints, and erection of any long span members. The standard of calculations and drawings was variable and to some extent reflected the ability of candidates to manage their time effectively. Method statements tended often to be too generic and did not address the specific issues of the question, while overall construction duration and sequencing was generally poorly understood.

Question 6. Waterside Administration Building

Candidates were required to design a single-storey building, octagonal in plan, either over or in a tidal lake. This provided the options for either fully-fixed or floating structures. The main problems were associated with working in or over water and the constraint imposed by the existing sheet-piled wall along the lake edge. Solutions in steel, concrete, timber and masonry were viable.

One possible solution would be a steel superstructure with columns at the corners of the octagon, main beams running towards the lake, secondary beams parallel to the shore, and with suspended floor slabs. The terrace would be supported by cantilevered beams. Columns would have pinned feet and a portalised superstructure meeting at the apex. Piles at column positions with the heads tied by the grid of beams could be used allowing for submerged conditions. Lateral loads would be resisted by portal frame action and would be transferred to the piles by the grid of beams/ floor plate action. The piles would need to be designed for lateral loading as tied vertical cantilevers. Slabs could be *in situ* or precast concrete.

A second possible solution would use a sheet-piled wall with stabilised ground behind, with a ground-bearing reinforced concrete slab or a grid of r.c. ground-beams and suspended slabs. An alternative would be reclaimed land formed with a suitable slope into the lake and with large boulder or concrete protection measures. Variations in water level would need to be allowed for and any settlement of the infill material would have to be taken into account in the design of the superstructure. The superstructure could be in load-bearing masonry with a ring beam supporting a timber pitched roof or a timber superstructure. Stability would be provided by frame action of the masonry walls.

In view of the small size of the structure and constraints of building over water, it was hoped that candidates would show initiative and suggest a pontoon to provide a floating structure as a viable alternative. Such a structure could be constructed off-site without concern for weather conditions; however, candidates opted for conventional solutions. Many candidates provided piled and cofferdam options. Some offered similar options using variations on the pile layout. A few proposed temporary cofferdams for constructing spread footings at depth into the stiff clay, making it a very expensive option. Where permanent cofferdams were used there were few calculations for these key structural members, and many candidates failed to recognise the requirement for stability of the columns or piles below the water level.

Ideas for reducing costs are given below, most of which were identified by good candidates.

- Cost and time reductions could be achieved if the client accepted a horizontal ceiling so that proprietary timber trusses could be used, avoiding the need for portal or ring beams, and the roof space could also be used for storage and/or services.
- Prefabricated components, particularly over water, would reduce on-site costs and require less reliance on good weather.
- If the client would consider moving the building towards the land but leaving the terrace to cantilever over the lake (since this would still afford the panoramic views over the lake) large reductions in cost could be made through not working in/over water.
- A rectangular plan shape for the building with a pitched roof would increase the usable area and would improve the internal circulation and display areas, and would avoid the complex apex connection.
- Careful detailing and integration with services could reduce waste and hence costs.
- Off-site fabrication, floating the structure into place on to piled foundations, would reduce costs.

Calculations were often poorly presented making it very difficult for the examiners to follow, and marks were reduced accordingly. Where members are continuous, as in portal frames, it is not sufficient to simplify the analysis to a simply-supported member. Good candidates appeared well-versed in using section tables in arriving at member sizes: limiting the design of a beam to its bending capacity is not sufficient – deflection and shear need also to be considered. Marks were lost for grossly uneconomical options. Most candidates provided adequate solutions for the structural frame but the load path and frame stability were often poorly explained thereby losing marks. Good candidates recognised the requirement for stability of the columns or piles below the water level. Key details expected to be drawn included: the foundation to platform beams; the superstructure to platform beams; overall stability; the ring-beam to the curved roof-light; the interface with the existing sheet piled wall. Some candidates attempted to save time by trying to show a foundation plan, floor plan and roof plan on a single drawing but this was often confusing and lost marks.

In part 2e method statements were generalised and often did not convey the critical structural aspects for the safe erection of the chosen scheme. Some candidates provided a programme, but this was not required and wasted valuable time. Good candidates correctly identified many of the constraints of working over water, providing stability during construction stages, and allowing for interruptions during bad weather.

Question 7. Substructure for a wellhead platform

Candidates were required to design a substructure for a small Topside, located in 75m of water. The only constraint for the design was that the top of the substructure had to interface with the Topside gridlines at 12m × 12m, providing significant scope for substructure concept solutions. Wave pressure and simplified soil data were provided.

All candidates selected a conventional 4-leg braced jacket as their preferred option. Good, distinct alternative schemes were proposed in Vierendeel and monotower form, with variations on the number of legs, foundation format and installation method. Concrete solutions were also possible, in either the conical or monotower form with gravity base or piled support options. Candidates were generally comfortable with the structural descriptions, though they did not always demonstrate a good understanding of the temporary condition load paths and their influence on the structural arrangements. Some candidates struggled with pile configurations and design fixity assumptions that lead to a simplified design solution.

Candidates were asked in part 1b to look at the implications of adding a further eight conductors to the substructure. The significant issues, namely increased wave load on the platform and the necessary changes to the structural arrangement, were correctly identified. The geometry was not adequately addressed, with proposals placing conductors 'outside' the structure. The implications were: substructure member size increases and the influence of increased structure weight on installation operations, the required increase in foundation capacity, and the influence of boat impact on the conductors adjacent to the structure perimeter.

The substructure solutions proposed were of simple structural form, such that the selected member sizes could be demonstrated by simple calculations. It was therefore expected in part 2(c) that candidates would successfully identify the critical design conditions for the components. The governing case for the legs and pilings was the in-place condition, specifically the diagonal wave direction case, which was not always identified as dominant. The frame bracings were governed by the in-place, lift or transportation conditions, depending on the selected locations of lift points and transport sea-fastenings. The assessment of critical conditions and loading determination, for these components, was considered significant in demonstrating a complete understanding of the nature of offshore platform engineering.

Candidates were required to sketch their structural arrangements, particularly the lift points which have such a significant influence on the structure design, and the interface with the foundation and Topsides. Good sketches, to scale, enable a critical review of their design proportions, consistency and joint eccentricity issues that are not immediately apparent otherwise. In this case, most candidates left insufficient time to complete the sketches and lost this benefit.

The method statement was generally well produced, comprising the straightforward substructure transport to, and installation at, the field location. An important procedure to be included would be continuing weather-forecasting and monitoring during the operation, weather being the principal constraint for commencement of the Sailaway and Lift operations. These operations, though short and well-managed, may be jeopardised by simple errors such as inadequate sea-bed checks for debris and slope, inadequate releasing of sea-fastenings prior to the lift and inadequate rigging control and clearances.

Question 8. Tourist observation gallery

A small two-storey building with roof terrace was required to provide an observation gallery and visitor centre in a remote scenic area. The centre was to be placed at the top edge of a steep cliff, being partly buried into the hillside, and partly cantilevering out over the cliff. The most significant environmental loading was seismic; the 475 year return peak ground acceleration on rock was 40%g, which placed the site firmly in the 'high seismicity' category. As in previous years, the question was structurally quite straightforward and no restrictions were set on the placing of support systems. Instead, a broad requirement was given for the building to 'minimise the visual and environmental impact on its surroundings', leaving candidates very broad scope for choosing structurally-efficient solutions which were functionally and visually appropriate.

Timber, steel or a combination of the two were the most suitable options for structural materials. Timber has positive visual and environmental qualities but in an unpropped solution might have been difficult to make work without obscuring views, unless combined with steel ties. Steel is lightweight and easily transportable, and tension-only bracing could have been employed as an efficient solution minimising visual obstruction. In the event, all candidates opted for steel or concrete.

The cantilevering of the building out over the cliff posed clear problems both for stability under gravity loads, and also for the potential for the centre of foundation resistance to be some distance from the centre of mass of the building, leading to significant torsional response under seismic loading. Most candidates recognised both aspects, but the extent to which they showed initiative in developing imaginative structural solutions to address them was, even with the best candidates, frankly disappointing. It was easy to design cantilever beams or trusses to take the gravity loads back to the hilltop, but this needed be done without impairing visitors' views of the scenery which was clearly a prime purpose of the building. The cantilevers had to be sufficiently anchored, and the torsional response set up by the large eccentricity between the centres of mass and stiffness needed to be addressed. Vertical supports from the end of the cantilever down into the cliff below were possible, as many realised: this solved the gravity stability problem, at the expense of some visual and environmental intrusion, but to make the supports stiff enough laterally to take out the torsional seismic response without major intrusion was probably impossible. Inappropriately, some candidates decided to place a movement joint between the two- and one-storey sections to make a more 'regular' structure, but in fact this did little to resolve the torsional issues while making them harder to cope with. Simple methods of analysis in seismic codes are not set up to deal with unusual buildings like this one and a conservative approach to the seismic calculations was indicated. Ideally, a low ductility demand would have been chosen at this scheme design stage (not a major penalty for this structure) and a recommendation made for more sophisticated analysis at a later stage, but no candidates referred to this.

The letter to the client (part 1b) required observations on the feasibility of extending the roof terrace by a rather daring semi-circular walkway which cantilevered further out from the cliff. The walkway added about 30% to the roof terrace area, so strengthening the rest of the structure to take the additional gravity and seismic loads would certainly have been feasible and would probably have had relatively little impact on member sizes, though of course much more on programme and cost if fabrication had started. Controlling the dynamic response of the cantilever to walking (or, of course, jumping) might have been more of a problem. Detailed treatment of this in the letter was not expected, but disappointingly no candidate even referred to it. Various solutions to provide adequately stiff support to the cantilever walkway were possible, and the examiners would have been well satisfied with a list of the issues, sketches of one or two options to consider further and a recommendation for detailed studies, but this part of the question was not well tackled.

Associate-Membership Examination 2008

This year the Associate Membership Examination was attempted by 26 candidates, a small increase in the number of candidates from last year. Eighteen candidates (69%) passed the examination. The examiners are encouraged by the fact that a similar percentage of candidates pass this examination each time, and the examiners were pleased to recommend a candidate for an award again this year.

Since April 2003, in the Associate Membership Examination, candidates have been required to answer one from a choice of six questions. As with last year's exam, this year it was again noticeable that candidates favoured one particular question, although other questions were attempted. From 2009, AM candidates will be required to answer one question from a choice of only four.

Below are set out the key features of each question, together with general feedback on various sections.

Question 1. Warehouse and Office

This question called for the design of a new warehouse with an adjoining two-storey open plan office on the outskirts of a large city.

There were a number of key challenges, which included:

- No columns permitted within either the warehouse or office areas.
- The ground-floor level of the warehouse and the loading area was 1.5m below the existing ground level.
- Delivery doors 6.0m high and 5.0m wide were required throughout the loading area elevation of the warehouse.

Question 2. Office Building

The question called for the design of a new four-storey office development in an inland city centre, set in a triangular site plan.

There were several key challenges, which included:

- The curved elevations were to have full height glazing, whilst the straight elevations were to have brick cladding.
- Only a single line of internal columns was permitted along each of the axis lines AX, BX and CX; and these were to have a minimum spacing of 5.0m.
- Bracing was only permitted in elevations with brickwork, and was not permitted in the office space or glazed elevations.
- Staircases and lifts were outside the building line, and were structurally independent of the building.

Question 3. Replacement Pedestrian and Cycle Bridge

This question called for the design of a replacement pedestrian and cycle bridge for a national cycleway crossing a river.

The key challenges for this question were:

- The existing bridge had been damaged by an exceptional flood, such that the superstructure needed to be completely replaced: this comprised a half-through steel truss with a concrete deck.
- The existing mass concrete construction abutments appeared to be sound and re-usable.
- No new piers were to be permitted.

Question 4. Custom-built House

The question called for the design of a custom-built house comprising of slabs, walls, and a group of six columns with flared heads supporting the roof of the curtain-wall-clad 'principal drum' containing the living area.

There were a number of key challenges, including:

- The varying levels of the living accommodation because of the hillside location of the building.
- Access to the building was via a footbridge.
- The living area had a fireplace that incorporates a free-standing chimney.

Question 5. Workshop and Office

This question required the design of a workshop and office for a concrete raft and boat systems supplier within a large site in a light industrial area. The client had a strong preference for the use of concrete wherever possible.

The key challenges in this question were:

- The ground floor workshop area was to have no internal columns.
- Two runway beams, each capable of lifting 50kN point loads anywhere along their length, were required to service the workshop.
- Perimeter columns were not to be spaced closer than 6.0m.
- A clear headroom of 4.8m was required in the workshop and 2.5m in the office, whilst no part of the structure could be higher than 10m above ground level.
- The stairs to the first-floor office were to be non-structural, and could not be used to provide lateral stability to the building.

Question 6. Clubhouse

The question called for the design of a new building for a clubhouse within a woodland setting.

There were several key challenges to this question, including:

- The building needed to be designed such that it was sympathetic to its woodland surround setting.
- To minimise the work on site, the building was to be constructed from prefabricated elements wherever possible.
- The interior of the building was to be kept free from obstructions.
- An open balcony area with a minimum of obstructions was to be provided at one end.
- The site could not be accessed by large vehicles or heavy construction plant.

Feedback

Section 1a

Most candidates offered a reasonable structural solution. In a few cases, the stability aspects were vague, difficult to follow, even the possibility of having an unsafe structure. Future AM candidates should consider that the most effective method to describe functional framing is through diagrams. By adequately dealing with this aspect, candidates will be better able to demonstrate their understanding of structural behaviour.

Instances still occurred where candidates did not fully take into account the limitations given in the client's brief, thus changing the conditions set within the question, whilst others attained low marks because of not allowing sufficient time and attention to design detail.

Section 1b

This section introduces a specific client change that involves an additional structural engineering challenge. It is important that candidates recognise this challenge and deal with the structural engineering implication of the client change. Several candidates did not clearly outline the full structural implication, and how the client's request might be achieved.

Section 2c

As in previous years, some candidates incorporated insufficient calculations to establish both form and size of all the principal structural elements. AM candidates need to consider how their proposed solution is sub-divided into principal structural elements. Those candidates obtaining low marks in both sections should take this as indicating a need for better preparation, improved time management and more practiced exam technique.

Section 2d

Generally, this year, drawings were of a reasonable standard. Unfortunately a number of candidates did not supply what was clearly asked for in the question – plans, sections, elevations and two specified details. It is important that sufficient layouts, views, dimensions and a clear disposition of structural elements are given, along with comprehensive detailing, to meet this requirement and allow for adequate cost estimating.

Section 2e

Some method statements were inadequate because candidates left insufficient time for this section and often omitted essential information. Candidates are again reminded that marks can be gained by ensuring that this final section is given appropriate attention.

- For more information regarding future Associate-Membership examinations from 2009 onwards, refer to the Institution website and the article in the 19 August 2008 issue of *The Structural Engineer*.

Pass-rates per question

CM 2008

Question	Pass	Fail	Total	%Pass
Q1	22	42	64	34.4
Q2	75	144	219	34.2
Q3	23	29	52	44.2
Q4	91	177	268	34
Q5	20	26	46	43.5
Q6	20	20	40	50
Q7	6	4	10	60
Q8	2	5	7	28.6
Total	259	447	706	36.7

AM 2008

Question	Pass	Fail	Total	%Pass
Q1	9	4	13	69.2
Q2	3	2	5	60
Q3	0	0	0	0
Q4	0	0	0	0
Q5	1	0	1	100
Q6	5	2	7	71.4
Total	18	8	26	69.2