Examiners Reports 2009

The examiners' reports are to be read with reference to the April 2009 question paper available from the Institution at £3 for members and £4 for non-members

Chartered Membership Examination 2009

This year's examination was attempted by a total of 753 candidates, 46 more than last year, of which 394 took the examination in the UK and 359 throughout the rest of the world. The UK pass-rate was 40.4% with 159 passes and the overall non-UK pass-rate was 30.1% with 108 passing. The Hong Kong candidates' pass-rate was 28.6% and other non-UK centres' pass-rate was 33.3% The overall pass-rate for 2009 was 35.5%, a slight decrease on last year.

The examiners draw future candidates' attention to the themes below which re occur each year. Common causes of failure continue to be time mismanagement and unreadable handwriting and diagrams.

– 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 only as a checklist of items to be considered which needs to be expanded with detail. 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: Office Building Incorporating an Existing Stone Tower

The question required candidates to consider a situation in which a conventional office building was to be partially constructed within an existing structure. The straightforward brief gave an advantage to competent candidates who were able to demonstrate their understanding of structural behaviour and their ability to conceptualise different structural arrangements.

The brief required an open glazed structure with minimal interruption to the floor plate. It also required candidates to deal with poor and highly-variable ground conditions, as well as keeping the new structure clear of the existing.

Successful candidates offered solutions for bracing the building which included either a moment frame, but with attention given to lateral deflection limits, or bracing the structure within the protrusion into the stone tower and providing an additional line of light bracing within the building to deal with the torsional component. Some proposed one or more substantial braced cores within the new office footprint but these tended to take up too much floor space. Other candidates struggled to convey a credible overall stability model without reliance on stair cores, internal cross bracing or shear walls and this aspect generally divided successful from unsuccessful candidates. When presenting distinct options, simply changing the construction material from steel to concrete while using the same grid was not considered satisfactory. Successful candidates gave clear and valid reasons in justification of their selection of the preferred scheme.

Ground conditions were reasonably well-considered with piling being the preferred solution. Some successful candidates recognised that a combination of foundations could be used: piles, where rockhead was deeper, and mass-fill foundations to shallower rockhead.

In part 1(b), candidates were required to consider the effect of including an atrium. Successful candidates wrote their letters in an acceptable business format. The implications of the change, both technically and on programme, were generally recognised; however, some candidates failed to realise that the end wall would be laterally unrestrained for the full height of the building, and if their scheme used the end wall for bracing then an alternative load path would be required. Candidates gained marks for being specific about the structural effects, demonstrating their understanding.

In part 2(c), successful candidates included calculations for the sizing of the overall stability systems and demonstrated that the lateral load paths in moment frames were satisfactory. The level of detail required was as should be undertaken by hand when checking that the output of a computer analysis is correct. Pile designs were often poor and produced excessive results, and many of the raft schemes proposed would be very sensitive to differential settlement. Candidates are recommended to devote sufficient time to deal with the primary structural framing and foundation issues, and spend less time on simple gravity calculations.

Good candidates produced high-quality drawings which properly conveyed their intentions. Sketches remain extremely important in the design office to convey the designer's intent, and candidates are recommended to spend more time practicing creating drawings particularly where they may have little regular direct involvement in this aspect within their workplace. Critical details were often poorly executed with little comprehension of good detailing e.g. blending concrete below foundations, pile/pile-cap interface relationship, and movement provision at floor/cladding interfaces.

Some candidates provided good comprehensive method statements which addressed the specific construction safety risks resulting from their design. It was not acceptable simply to list generalised cautions covering hard hats, safety fences and eye protection (for which each site operative has personal responsibility) while neglecting temporary stability issues which are solely the domain of the structural engineer.

Question 2: Hazardous Liquid Storage Building

The question required candidates to design a waterproof building on an island for storing two tanks containing hazardous liquids, and a structure to transport the tanks from the edge of the island to the building.

The key problems for candidates to solve were as follows. The ground was poor which meant that piling was required for the foundations and mobile cranes could not be used to transport the tanks during normal operation, but to enable installation and removal of the tanks at least one crane was required. A crane or rails were needed between the edge of the island and the building. The tanks needed to be lifted from the barge before being transported to the building. A door was required to allow access for the tanks into the building.

The question was more complex than Question 1 in terms of interpreting the information supplied and the constraints on solutions. It had the additional complication of having two essentially separate parts: the crane/loading structure, and the building itself. However, once the brief had been understood, competent candidates found it straightforward to propose solutions. Successful candidates were able to demonstrate an understanding of structural behaviour and an understanding of the problems connected with a relatively highly-loaded building with significant lateral loads (crane surge), all on poor ground.

A number of different options for the building were viable depending on the positioning of the tanks. Positioning the tanks parallel to each other would reduce the overall length of the building. Positioning them in line would reduce the span of the beams supporting the tanks. The use of either steel or concrete frames was feasible but the considerable weight of the tanks required substantial element sizes. No building size was specified, but candidates proposing buildings larger than the minimum required were not penalised.

For the transfer structure to move the tanks to the building, solutions with mobile cranes were not acceptable unless, for example, a road supported on piles was also proposed. Solutions involving ramps would require some method of lifting tanks from the barge and moving the tanks up the ramp. An obvious solution was to continue the crane gantry from the building to the edge of the island, taking account of the stability of the columns without infringing the movement of the tanks. Another possible solution was to place the tanks on rails at ground level. This would require separate cranes for unloading the tanks from the barge and lifting them into position in the building; however, it would remove the need for supporting superstructure.

Candidates' scripts were generally of a good average standard. Successful candidates understood the basic factors used to account for dynamic loads in crane structures. Some displayed an imbalance of effort between the two main sections of the question, with comprehensive proposals in the first but a lack of detail in the second suggesting time mismanagement.

In section 1(b) candidates were expected to demonstrate their understanding of ground floor slab design on a weak soil. Many letters offered were to a good standard and used clear and appropriate English to apprise a client of the implications of a proposed change.

Overall, this was a relatively complex question in terms of the initial brief. Once this was understood it gave an ideal platform for a full and comprehensive solution.

Question 3: Footbridge

Candidates were asked to design a footbridge giving pedestrian access to a commercial centre, crossing over an urban highway. A ramp was required between ground level and the deck 6.2m above. The footbridge was skewed on plan at 30º to the highway, and there were constraints on the deck thickness and supporting column positions. Ground conditions were straightforward, and spread footings on the sandstone were sufficient.

In section 1(a), successful candidates appreciated the requirement to provide a free and clear passage for bridge users, and avoided obstructing pedestrian access with elements of the bridge structure, particularly where the access ramp met the bridge deck. Examples where problems arose included placing the diagonal member of a Warren truss or an upstand beam across the top of the ramp, or placing cables for a cable-stayed solution or a central pylon in the middle of the deck. Some candidates overlooked the need for the deck and ramp structures to overhang or cantilever at their junction because no columns were permitted at this position, and some otherwise satisfactory schemes contained U-frames with unbraced top chords and the U-frame action not considered. Successful candidates offered two schemes distinguished by different load transfer methods.

In section 1(b), successful candidates suggested a portal frame as an alternative form of support following the client's change of requirement. Candidates who copied standardised bullet points from a sample answer script obtained from an examination preparation course lost marks since they appeared unable to discriminate between what was valid and relevant to the question and what was not.

Section 2(c) was generally well-tackled and many candidates provided calculations which were satisfactorily presented and covered most of the structural elements. Wind loading and thermal effects were generally ignored. Piled foundations, although not realistic in this case, were still proposed by some candidates. In section 2(d), successful candidates produced good-quality drawings with sufficient information.

In section 2(e), method statements were generally acceptable but some candidates had not taken into account the difficulty of working above a busy road and neglected the practical and safety issues. Several candidates produced unrealistically-short construction programmes through lack of experience, with 5 months being the minimum realistic period needed.

Question 4: Commercial building

Candidates were asked to design a seven-storey commercial building on a level square site. One of the façades was inclined, increasing the building in size towards the top. Two services cores were provided but were structurally independent of the main building. Structural walls were not permitted. A number of planning restrictions were imposed by the client, including a minimum passage width, the omission of a corner column, and foundations required not to extend beyond the site boundary. Ground conditions comprised loose fill over a shallow layer of sandy gravel, above weathered rock at 5m depth and hard rock at 8m.

There were various ways to arrange the main and secondary floor beams giving distinct solutions, and the use of waffle slabs was also viable. Floor beams could be connected to spandrel beams supported on perimeter columns. The omission of a corner column and the inclined façade suggested providing perimeter beams with cantilever spans to form the required layout. Spandrel beams above level 2 could be supported by closely-spaced perimeter columns; however, to accommodate the large-span entry points transfer arrangements at level 2 would be required. An alternative was to locate the upper floor perimeter columns on the same grids as the level 1 columns.

The services cores were structurally independent so candidates could not rely on them for the lateral stability of the building. This required the structural frames of the building to be designed to resist wind loads. Being a seven-storey building, the structure was also required to be designed and detailed for robustness.

The site conditions made shallow foundations difficult and some candidates used pad footings without considering the realistic ground bearing capacity. A possible foundation solution was end-bearing piles.

Section 1(a) required two viable and distinct schemes. Sufficient calculations were needed to substantiate the validity of both solutions. Solutions that did not satisfy all the client's requirements and the stability requirements were not regarded as viable.

In section 1(b), the candidates were expected to highlight the need to retrieve the design details and record plans of the existing piles, and to discuss the pros and cons of re-using the piles from the design, construction and economy points of view. Most candidates were able to address these key issues. Some candidates suggested avoiding re-using existing piles but generally failed to provide convincing reasons.

In section 2(c), successful candidates provided sufficient calculations to substantiate the validity of the principal structural elements, and took into account the wind loads.

In section 2(d), good candidates prepared well-presented drawings, and gained marks from their success in communicating the details of their design through the plans, sections and elevations. Some candidates attempted to cut down the work by squeezing unsymmetrical parts on a single plan and produced confusing details, and this generally failed to attract marks.

In section 2(e), candidates were expected to address the safe construction of the tall building including the foundations, in particular the overhanging elements forming the inclined façade. Those who merely produced a general list of concrete construction activities and completely ignored the foundation works did not gain high marks.

Question 5: Art Gallery

The question required candidates to design a two-storey art gallery with provision for car parking on a sloping site with a buried culvert. The footprint required for the lower floor (level 1) was greater than that of the upper floor (level 2). A site plan was provided but candidates were free to select the form of the building and its position on the site within specified dimensional parameters.

Various layouts were possible, each with advantages and disadvantages. The car park could be provided at level 1 or at level 2, and the long elevation of the building could be located parallel or perpendicular to the culvert. The upper level could be positioned anywhere within the footprint of the lower level or could cantilever beyond it on one or two sides.

Candidates were expected to understand the structural implications of their choice of building location and be able to discuss the relative advantages and disadvantages of the alternatives considered. Positioning the building to the east of the site and providing a level 1 car park to the west side would mean that the lightly-loaded car park could be constructed over the culvert; however, this solution would involve a large amount of excavation and the construction of a significant retaining structure. Switching the two around and providing a car park at a higher level would reduce the amount of excavation, although it would place the heavier building over the culvert. Turning the building through 90° would mean that parts of both the building and the car park would have to be built over the culvert. Constructing the car park on the building at level 2 would reduce the amount of earthworks required: although the loading would be increased slightly, the cost of roof finishes and waterproofing would be increased and a means of vehicle access to the building would need to be provided.

Foundations were relatively straightforward although some form of bridging structure was required over the culvert, and candidates had to take care not to surcharge the culvert with either vertical or lateral loads. Most candidates recognised this need, although some bridging solutions were somewhat over-engineered. Taking foundations to the bottom of the culvert would put the excavation below groundwater level. Piles were frequently proposed as a foundation for the building, which would have been expensive.

Viable options for the structural frame were concrete, steel or a combination of materials. If candidates adopted the minimum 7m grid a transfer structure would be required at level 2. The alternative would be to use longer-span beams and larger members. It was anticipated that candidates would use the stair and lift cores for stability. A retaining structure was required on three sides of the building and thought had to be given to possible surcharge from car parking.

Despite the numerous possible alternatives for both site layout and building arrangement, few candidates produced two distinct schemes. The first scheme was frequently adequate but the second scheme was often not well developed. Some used the same grid layout for both schemes and some failed to take the opportunity to change the location of the building in the second scheme. The implications of the sloping site were often ignored and some candidates failed to make provision for the necessary retaining structures. Several saw the question as relating purely to the building and concentrated their efforts on the gallery structure while ignoring the site-wide implications. Successful candidates demonstrated an understanding of the implications of the site topography on the position of the building and were able to propose reasoned arguments for their selected schemes. High marks were awarded to those who tackled all parts of the question including the method statement and the programme.

In section 1(b), candidates were expected to discuss ways in which their chosen scheme could be modified to allow additional parking to be incorporated. Depending on the scheme they had chosen this could involve surface (level 1) parking, level 2 parking or even basement parking although this would be expensive and consideration would need to be given to the provision of suitable gradient access ramps and the problem posed by the presence of the culvert.

Calculations were expected for the main structural frame members at each level, foundations (including any structure bridging the culvert) and retaining wall. The method statement should have considered access for construction vehicles, protection of the culvert during construction, removal of excavated material and the need for any dewatering. Good candidates prepared calculations for principal elements such as retaining walls or cantilevers, rather than unimportant minor elements. Some solutions proposed were impractical, such as beams with too high a concentration of reinforcement. Drawings were often not sufficient for estimating purposes and in many cases did not include a site layout or cross-section, both of which were essential to describe the scheme. Details were often generic rather than being of principal elements or critical items. Method statements were too often simply a list of operations without any recognition of the critical issues and without any explanation as to how the works were to be constructed.

Question 6: Research Building Extension

The client's brief was for the design of a 3-storey extension building on good ground conditions. The main constraints were the proximity of the adjacent occupied building, the steep access road, the link corridor and the constrained sloping site.

In section 1(a), viable solutions included a steel frame with precast or composite flooring, a timber frame, a concrete frame, or load bearing masonry. Perimeter retaining walls would be required on the exposed sides of the sloping ground because of the adjacent building and access road. A feasible solution would be a framed building comprising columns at all corners and intersections of the elevations, with perimeter beams and a single internal column. A layout might comprise typical slab spans of 3 to 4m supported on secondary beams (typically 6m spans) which in turn would be supported by primary beams (typical spans of 7m approximately). Stability could be provided by vertical bracing in both directions away from window openings or by portal frames or shear walls. Columns would typically have pinned feet. Alternative schemes could be precast concrete panels or masonry elevations with flooring spanning on to internal primary beams. Some candidates failed to recognise the small size of the building when proposing load-bearing masonry and provided unnecessary and uneconomical diaphragm walls. Most options proposed were steel or reinforced concrete frames, with a few suggesting load-bearing masonry or concrete walls. Good candidates included proposals for the roof structure. Most candidates produced some form of cantilevered foundation against the adjacent building, but several decided to underpin the building as well which was not appropriate as it would create a hard spot. Stability was generally adequately addressed.

The ground conditions were good, with suitable bearing strata at a shallow depth for traditional pad foundations. Because of the sloping ground, foundations would need to be stepped to avoid deep excavations and disturbance to the adjacent building and access road. The use of mini-piles as an alternative to pad foundations was a viable solution. The existing 5-storey building had spread footings, from which it would be reasonable to assume that similar footings would also suit the proposed 3-storey extension. It was therefore disappointing that several candidates proposed large-diameter bored piles which were not appropriate, nor would it be very feasible to provide access for the large piling rigs needed.

Successful candidates not only considered the main structural frame when describing the alternative solutions, but also discussed treatment to the external elevations, the implications of the access road and how the extension would abut the existing building.

In section 1(b), the sloping ground necessitated the need for external perimeter retaining walls to the exposed elevations. The client's request for a basement could therefore be incorporated without difficulty by adding an internal retaining wall to hold back the higher ground to the south end of the building. Also, a basement would reduce the need for backfilling excavations to the adjacent foundations to the extension. Many candidates correctly identified the best location for the basement as at the north end of the extension. The main aspects that needed to be addressed were the preferred location for the basement, the proximity of the adjacent building, the implications on the access road, the requirement for retaining walls, and the need for damp-proofing. Many candidates focused on the additional design fees due and the programme but, while these may be mentioned, the technical aspects should form the main part of the letter.

In section 2(c), the typical key elements to be designed were the floor slab, the primary and any secondary beams, an internal and an external column, stability bracing (portal frame, shear wall, etc), roof mono-pitch members, link corridor beams allowing for the cantilever because of foundations being set back from the existing building, and the foundation pads, strip footings and perimeter retaining wall. Candidates who selected load-bearing masonry without other bracing were expected to provide detailed calculations both for vertical loads and for lateral wind loads.

Calculations varied from the very detailed for only a few structural elements to the over-simplified, but many candidates were able to present legible calculations which were easy to relate to the drawings and made good use of safe-load tables. Candidates should include deflection checks as well as checking shear and bending. Members in combined bending and axial load also require an interaction check. Once one key element subject to a particular load pattern has been designed it is not necessary to provide repeat calculations for similar members.

The section 2(d) drawings were generally of a good standard but some contained insufficient information. Candidates providing only freehand sketches with illegible writing lost marks. Critical details were often very limited and failed to demonstrate an acceptable knowledge of building construction. Many candidates did not offer critical details and several did not provide even an elevation, thus losing marks.

The section 2(e) method statements are expected to describe the safe construction for the whole of the works. Few candidates achieved this, with many listing only 8-10 key tasks. An acceptable programme duration range was 32-40 weeks excluding internal fit-out. Good candidates made their method statements site-specific and included a condition survey of the existing building and external services in the area of the proposed extension before, during and after completion of the works. Other items mentioned which gained marks included:

– Confirmation of ground conditions and existing foundations including testing for possible ground contamination. Giving feedback to the designer where ground conditions differ from those shown on the contract documents;
– Stability of the access road;
– Construction sequence, temporary loadings and any restrictions on access and timing which the contractor has to comply with particularly due to the shared access road. For example the link corridors would be later activities to minimise disruption to the existing building.
– The use of off-site fabrication and avoidance of long individual members would be appropriate for such a constrained site.
– Just-in-time procurement would avoid the need for a large on-site storage area.

Question 7: New Flare for an Existing Offshore Platform

Candidates were required to design a new flare to be offshore-installed on an existing platform. The flare tip had to be 60m laterally and 60m vertically above the Weather Deck of the Topsides, but within this constraint candidates could choose support locations from those identified on the end transverse truss of the existing Topsides. This provided significant scope for alternative structural configurations.

In section 1(a), all candidates selected rectangular and triangular structures as the alternative configurations for comparison. Other viable solutions are tied back, or inverted triangular flares, both types of structure in use globally. Good candidates gave due regard to the in-place and temporary conditions (load-out, transportation and lift), recognising their influence on the framing and member sizing of offshore structures, and provided good explanations of the structural behaviour.

The letter in section 1(b) asked candidates to investigate the implications of supporting an exhaust duct, from a gas turbine, on the lower half of the flare structure. Most candidates identified the significant issues, namely the increased dead and wind loads caused by the duct and supporting steelwork and the consequential increased loading on the flare during the temporary and in-place conditions.

In section 2(c) the calculations presented often lacked clarity and the fundamental dead and wind loads were often poorly determined. Candidates need an understanding of the size of forces involved, in order to recognise cases where estimated loads are clearly not credible. The design of structural elements using poorly-derived loadings led to unrealistic member and detail sizing. Good candidates reconciled their initial dead load estimate with their final designed weight to confirm the validity of their calculations. The supports needed to be considered: they are important for any structure but critical for a flare.

In section 2(d), candidates were expected to draw their structural arrangements, including the lift point and permanent support detailing. Good-quality sketches, drawn to scale, are important for clarifying design submissions and identifying the detailing necessary to maintain a viable arrangement. Single line drawings are not as useful, as joint eccentricities are not apparent and sensible design proportions may not be verified by simple visual checks. Candidates must endeavour to provide drawings consistent with the design calculations. As in part 2(c), candidates are reminded of the importance and significance of the support point detailing.

The method statement in section 2(e) required candidates to describe the sequential steps involved during the transportation and installation of the flare. Important procedures to be incorporated included continual weather forecasting and monitoring, weather being the principal constraint on commencement of the sailaway and lift operations. An understanding of offshore installation methods was necessary, as the flare has to be lifted by a Heavy Lift Vessel, guided into position, hooked onto the deck structure and rotated into position, and lack of appropriate experience was apparent in some submissions.

Question 8: Support Structure to a Petrochemical Processing Facility

The 'seismic' question, for the first time, did not address a building structure but a simple unmanned petrochemical facility standing in 14m of water. The design wave height was only 1m and the design wind speed was moderate, thus most candidates appreciated that the main structural design issues were to carry the 20MN gravity load of the facility safely to the foundations, and to remain stable under the lateral inertia forces generated by a severe earthquake. The foundation conditions were benign, with reasonable soils located within 3 to 4m of the lakebed.

The question specified that 'life safety' performance should be achieved in the 5 000 year return period design earthquake, and a definition of this performance level was provided, based on that given in Eurocode 8. It implied that the structure should remain stable during and after the design earthquake, but (given appropriate design and detailing) large post-elastic deformations might be possible. Some candidates, however, assumed that a purely elastic response was required, leading to structurally inefficient solutions.

The basic structure therefore consisted of a straightforward support carrying a rigid payload above a shallow depth of water. Dynamically, it corresponded to the 'single degree of freedom' system encountered at the start of every structural dynamics course. It was thus dynamically different (and simpler) than a typical building, and so some code provisions for buildings, such as period and effective mass determination, were not entirely appropriate.

A variety of structural solutions was offered. Most candidates appreciated that the structure was best constructed on dry land and then transported to its inshore site; indeed, the wording of the question gave a clear indication of the need for this. Although detailed calculation of the transportation and installation conditions were specifically excluded from the question, viable solutions had to take them into account, at least qualitatively, and most candidates did so. However, not all realised that the 20MN payload should be transported separately, and then lifted into place once the support structure was complete.

Proposed options for providing lateral stability included concentric and eccentrically braced steel jackets, and a base-isolated solution was offered: all were potentially acceptable. An unbraced moment frame did not offer any advantages; usually, Vierendeel trusses only make any sense in the context of a building. Carrying the lateral loads by 'Eiffelisation' (raking legs) was a viable solution. Conventional concrete gravity bases or piled foundations were offered, but an *in situ* concrete raft (presumably built in a cofferdam) was impractical.

In section 1(b), most candidates showed they had grasped the implications of the design change requested. Carrying the same payload, but over an area limited to $^{2}/_{3}$ of the deck, rather than the whole of it, and with a higher centre of mass, changed the distribution of gravity loads in the support structure. More significantly, it gave rise to powerful torsional loading in an earthquake, and increased the overturning forces, particularly on the deck-to-module connections. Most candidates pointed this out, but some lost marks for not offering (in qualitative terms) structural solutions to address these issues.

The calculations and drawings presented were generally acceptable. The main conceptual error by some was to neglect the effect of seismic overturning forces on the vertical members of the support structure. Not all candidates realised that plan bracing between the vertical legs would increase their buckling resistance, and hence vertical capacity, as well as providing rigidity for the transportation and installation phases. The method statement and construction programme in section 2(e) were generally poorly addressed.

Associate-Membership Examination 2009

This year the Associate Membership Examination was attempted by 33 candidates; again an increase in the number of candidates from the previous year. Twenty candidates (61%) passed the examination, a slight decrease for the pass rate from last year, but it is encouraging that a similar percentage of candidates passes this examination each year. Regrettably, no prize award could be recommended this year.

For the 2009 Associate Membership Examination candidates were required to answer one from a choice of four questions, rather than six as has been the case since 2003. As in last year's exam, it was again noticeable this year that the candidates favoured two particular questions.

Question 1. New Shops and Residences

The question called for the design of a new town-centre infill parade of shop units with residential flats above. The development was to consist of five shops and 30 flats in total, with 10 flats on each level above the shops. There were a number of key challenges, which included the following: each shop unit was to have a clear internal width of 12m, with no columns permitted within the floor area of each shop unit; each shop unit also had to have a large clear opening to its front elevation and another to the rear elevation. Each residential flat was to have a maximum clear internal width with no projections and was to be column-free. The external cladding to the development was to be of cavity wall construction, while the roof was to have concrete pantiles on battens with insulation supported by timber rafters.

Question 2. Leisure Swimming Facility

The question called for the design of a covered swimming-pool complex for recreational use by a local council. A wave pool, a toddlers' pool, and a pool for general swimming, all rectangular in shape, were required. The three pools were to be set symmetrically within a circular ground slab, 28m in radius from a central internal roof support. A separate external building was provided for plant but was excluded from the design brief. A key challenge was the circular shape required for the supporting structure. The perimeter wall and roof structure could be of steel or concrete construction, but were to carry proprietary lightweight glazing panels which could span an area up to 5m by 5m. No internal columns were allowed except for the central support to the roof. The ground slab between the pools was to provide space for sitting out, retail outlets, internal landscaping and changing rooms.

Question 3. Bridge Replacement

This question called for the design of a new bridge to replace an old existing railway bridge that crossed a farm track, with the abandoned railway track and its embankment to be reinstated as a bridleway and footpath. The clear distance between the parapets of the existing bridge was 8.6m, but this could be reduced to 3.5m to accommodate the bridleway and footpath. The new farm access track was level, but required a clear height of 4.3m and a clear width of 4.5m. A maintenance vehicle weighing 100kN would service the proposed bridleway and footpath.

Question 4. Bird Hide Structure

The question called for the design of an enclosed viewing hide for a bird reserve with enclosed shop/display area below, measuring 8m by 4m on plan. The front and sides were to be constructed with the minimum of obstructions. The interior of the building at Level 1 and Level 2 was to be free from obstructions, with a minimum clear height of 2.75m at ground floor level. Level 2 was to be accessed via a single external stair.

Feedback

Section 1a

Most candidates offered a reasonable structural solution. In a few cases, the stability aspects were vague, or difficult to follow. 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 continue to occur where candidates do not fully take into account the limitations given in the client's brief, thus changing the conditions set within the question. Others attained low marks because of not allowing sufficient time and giving attention to the details of their design.

Section 1b

This part of the question introduces a client's request for a specific change that poses an additional structural engineering challenge. It is important that candidates recognise the challenge presented, state what it is, and deal with the structural engineering implications of the change. Several candidates did not clearly outline the full structural implications, nor how the client's request might be achieved.

Section 2c

As in previous years, some candidates incorporated insufficient calculations to establish both the 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. Candidates gaining high marks in both sections demonstrated good preparation, appropriate time management and effective exam technique.

Section 2d

Generally this year, a reasonable standard of drawing was achieved. 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 layouts, sufficient views, dimensions and clear disposition of structural elements are provided, 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.