The Institution of Structural Engineers

Report

Examiners' report 2010

The examiners' reports are to be read with reference to the April 2010 question paper available from the Institution at £3 for members and £4 for non-members

Chartered Membership Examination 2010

Questions

1. Yachting exhibition hall
2. Museum building
3. Bridge over a ravine
4. Cityscape development
5. Boat lift building
6. Administration building
7. New utilities module for an existing offshore platform
8. Extension office building in an area of high seismicity

Overview

Chartered Membership Examination	2010
Total Candidates	806
UK candidates	420
UK pass-rate	38.3%
Non-UK candidates	386
Non-UK pass rate	27.2%
Overall pass-rate	33%

The Institution is committed to assisting candidates to pass the Chartered Membership and Associate Membership examinations in order to achieve their personal goals of Chartered and Incorporated Structural Engineer status. The Institution is now able to provide a measure of personal feedback, comprising the marks awarded and individual comments from marking examiners, to unsuccessful candidates in order to assist them in their further attempts at the exams. The Examinations Panel, on behalf of the Institution, is pleased to note an encouraging response to this provision. Approximately 45% of unsuccessful candidates took up the offer of receiving personal feedback between 1st October and the end of the year.

The examiners draw future candidates' attention to the themes below that reoccur each year. Common causes of failure are time mismanagement issues and unreadable handwriting and diagrams.

Candidates should identify the crucial problems posed by their chosen question that must be solved for a successful outcome. They should communicate their understanding of these problems clearly and then address the problems in their proposed solution. They should produce calculations for the key elements and not spend too long on less important items.

Also:

- Candidates should avoid neglecting section 2(e) until the final part of the examination where time is limited. It is preferable to highlight matters of key importance in section 2(e) rather than prepare a list of activities.
- 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. Marks will be awarded reluctantly if examiners have difficulty reading a candidate's written answer or diagram. Candidates should ensure that their ideas are clearly and concisely expressed.

Question 1: Yachting exhibition hall

The aim of this question was to move away from conventional rectilinear structures whilst allowing the candidate as much freedom as possible with the structure. The building type, a yachting museum, was chosen as a slightly non-standard structure allowing 'non-building' candidates a chance to demonstrate their skills.

The interior of the building has a sloping face; the structure must be kept away from the outline of the yacht. The 6m limit had to be adhered to – encroaching on it was an automatic fail. All candidates mastered this constraint. Similarly, a 6m walkway all around and a floor area of a specified area were required. These constraints were so as to have a larger floor area at the +6m level but to allow a much smaller structure to be provided at higher floors. The tapering effect allowed candidates to move away from a conventional lateral-force-resisting system to a more economical A-frame structure that would be evocative of the shape of the yacht. The A-frame would be required to resist local horizontal forces but these are quite small. There was no limit on the structure within the walkways so a braced frame would be acceptable given the floor heights, creating a dramatic and economic structure. Regrettably, most candidates sought the security of a rectilinear grid system that provided far more space than required.

A hung interior, with four large corner structures carrying the load, was an option. One variant stipulated a heavy but dramatic structure that would let in lots of light. A number of candidates proposed this and created some good scripts.

Most candidates were able to provide two distinct schemes, but those who simply stated that the roof was a 'space truss', without any attempt to define what this meant and how it might work, were penalised heavily. When proposing a structural system, an understanding of how the system works must also be demonstrated. Some candidates failed to describe the structural systems adequately or they provided massive lateral force-resisting systems, such as large shear walls, which were excessive and contrary to the stipulation to 'let in lots of light'.

In section 1(b) the solution was quite simple: provide a trench to allow the yacht to be lowered under the floor beams. Some effort was required to deal with the temporary removal of columns. Candidates should be wary of proposing their section 1(a) structures in anticipation of the changes needing to be considered in the section 1(b) letter as this rarely produces economic or effective designs.

Calculations were of varied quality, with some candidates failing to focus on the critical elements. Some chose to spend significant time on the detailing of purlins but omitted the design of elements resisting lateral forces, thus losing marks. The calculations are expected to demonstrate the candidate's understanding of the critical parts of the structure as well as his or her ability to carry out robust sizing calculations. The examiner is not looking for blind adherence to a Code of Practice, but an ability to capture and describe the essential behaviour of the structure. The ability to recognise and address stability is crucial, especially for this structure where the floor heights were considerably greater than usual.

In the method statement and programme the main requirement was to consider the stability of the partially-built frame. Candidates needed to consider the important aspects of the programme rather than recite a list of preconceived 'dos and don'ts'.

Question 2: Museum Building

This question tested candidates' ability to think globally in relation to the overall building form and locally for each of the accommodation elements. Spatial considerations constrained the building geometry and height and ground conditions imposed further constraints. Candidates needed to take time to understand the question, which ultimately offered a relatively straightforward engineering challenge.

Many candidates did not address the rotational stability of the structure on plan, with only supporting frames being considered for stability. In some cases, candidates did not provide external bracing or moment connections around the circumference, and therefore proposed structurally unstable solutions.

Some candidates proposed over-engineered piled retaining wall solutions. The buildability of some clear-span solutions proposed was doubtful.

Ground conditions were generally well considered. The implications of the domestic refuse near the surface were recognised and tackled. More knowledgeable candidates identified the benefits of using common support lines along the storage area retaining wall lines. Many introduced nearby supplementary columns around the reading room and for an extended building perimeter.

The proposing of distinct options in 1(a) defeated some candidates who opted simply to change from portal to pinned framing whilst retaining the same primary grids. Sketching was, however, included in most answers. The second scheme offered was often impractical, though structurally sound. For example:

- using RC wall and roof slab behind the glazing (i.e. cannot see through the glass)
- having steel columns penetrating 5m into the ground to connect to the footings
- proposing double the volume of steel needed, half as primary structure, the other half for supporting glazing

As a result, some candidates struggled to explain the scheme and/or to provide sufficient appraisal of the two schemes.

In section 1(b) a business letter format was generally successfully adopted. The implications of the change, both technically and on programme, were generally recognised. Some scripts concentrated on superstructure issues neglecting substructure implications. Better candidates discussed how future completion of the entire building could be achieved.

Calculations in section 2(c) were of varied quality. Many candidates tended to focus on superstructure elements. The sizing of overall stability systems was regularly omitted. Pile designs, where adopted, were poor and often excessive. Common calculation mistakes included:

- no calculation for lateral stability
- retaining wall design focused too much on ground pressures and construction load and too little on supporting the column load from above

Drawings in section 2(d) were often less than satisfactory, perhaps reflecting a lack of regular direct involvement within the workplace in this aspect. In a number of cases the structural form was not fully conveyed by the drawing. Critical details were poorly illustrated with little comprehension of good detailing practice e.g. providing blinding concrete below foundations, providing basement waterproofing.

Method statements and programmes in section 2(e) were mostly acceptable where candidates had used their time wisely. Good candidates used sketches to illustrate erection issues. Overall, time constraints did not appear an issue; however, a few answers were grossly incomplete due to the candidate’s lack of appropriate experience of the building type.

Question 3: Bridge over a ravine

The question called for the design of a road bridge carrying a dual three-lane carriageway over a deep ravine. The bridge was to be part of a future bridge/tunnel project. There were constraints for the temporary and permanent piers and site access was extremely difficult. Candidates were expected to consider a light and easily constructed bridge structure to overcome the difficulties of access. The question provided scope for a large number of solutions with various forms, materials and construction techniques. In order to identify a viable solution it was essential that candidates properly considered the difficult site access.

In section 1(a), successful candidates understood the access difficulties and proposed light prefabricated or precast bridge components, launched from the existing highway. The constraints for the location of piers were well observed. Disappointingly, a few candidates treated the future tunnel as an existing tunnel for access. Some candidates did not acknowledge the site constraints, where the transporting and handling of long and heavy bridge components was difficult. Some candidates proposed solutions that proved to be impossible, and where a viable solution was suggested its methodology could have been better explained. Part 1(b) was generally answered well. The implication of raising the carriageway level in the proposed tunnel was mostly addressed and the chosen scheme was modified accordingly.

Part2(c) was adequately attempted but some candidates did not consider the method of construction, such as launching and staged construction, in their design calculations. Cable-stayed bridges are special bridges, and candidates should always consider the behaviour and characteristics of the cable-stayed bridge in their calculations. Treating the stay cables, in some cases, as rigid supports to the bridge deck was a fundamental mistake.

In Section 2(d), drawings were reasonably presented with plans, elevations and sections but some candidates were unable to provide enough details for estimating purposes. Section 2(e) was disappointing, as few candidates considered how to overcome the problems of difficult access and safety requirements. Construction programmes were generally satisfactory but some were too optimistic.

Question 4: Cityscape development

Candidates were asked to design a landmark building on an open site to offer a variety of shopping and entertainment venues and to provide panoramic views of the city. The question did not permit any vertical or inclined structural elements between levels 1 (ground level) and 2 other than the four service cores. The question also allowed only one internal column in each compartment above level 2.

Possible solutions were:

- deep cantilever beams at level 2 supporting perimeter and internal columns;
- both levels 2 and 3 carried by suspension from the roof.

Some candidates adopted a combination of both systems and produced a further viable scheme. One internal column was permitted in each compartment above level 2, but some candidates did not make use of this option and proposed 10m-long beams cantilevering from the core but within an allowable structural depth of 1.2m, leading to difficulties in substantiating the stiffness of these large-span elements. Many candidates introduced concrete hanger columns, apparently not appreciating that concrete is not a practical material to carry tension. A few candidates offered large-span cantilever beams supporting other cantilevers in orthogonal directions without considering the integrated stiffness and stability of the grid.

To pass section 1(a), sufficient outline calculations are expected to be presented to justify the validity of both solutions. Many candidates concentrated only on the preferred scheme and gave inadequate attention to the alternative solution. A few candidates merely presented sketches illustrating the schemes without including the scheme description. Some candidates took valuable time to copy out the question and thought that it might help to express their understanding of the requirements, but received hardly any marks for such work. Marks can only be awarded to the solutions, not the re-statement of the tasks to be carried out.

In section 1(b) the candidates were asked to give advice to the client about the suitable location of the skylights and the implications on the proposed structural arrangement. Those who gave only a few lines or specified fees or costs, without recognising the engineering issues, could receive only very low marks.

Sufficient calculations, concentrating on detailed analysis and design and referring to Codes of Practice, are expected in section 2(c) to substantiate the overall stability and validity of the principal structural elements, including the foundations. The adequacy of the building cores under eccentric loads and lateral forces was critical and should have been considered. Good candidates did not assume that wind loads were insignificant. They justified the stability of the cores with respect to the wind data given, and gained high marks accordingly. Many candidates adopted a simple span-depth ratio as the only constraint on the stiffness of large-span beams without considering the heavy point loads imposed.

Many candidates proposed bored piles bearing on rock as the foundation system. A viable alternative was driven piles. The compressive strength of rock was given in the question and candidates were expected to assess the safe bearing capacity with a suitable factor of safety. Very few noted the likelihood of negative skin friction on the piles from the reclaimed land.

Section 2(d) should include drawings of all principal structural elements. Marks were awarded according to how well candidates had communicated their design through the plans, sections and elevations. Many drawings were poorly presented and lacked sufficient plans and details to communicate the design. Some candidates squeezed several levels on a single plan and produced confusing details, in an attempt to save time.

In section 2(e), reference should be made to any major items of temporary works and specific measures required to ensure the safety and stability of the construction, especially the overhanging parts of the building. Many candidates ran out of time at this stage and produced only a generalised list of construction activities.

Question 5: Boat lift building

Candidates were asked to design a building for a boat ride at a theme park. The boats had to leave the building at ground level and return to it at -6.0m. Although some further dimensional requirements were specified, the general layout of the building was left to the candidate to decide. Ground conditions were sand and gravel with groundwater level at 5.0m below ground level.

Several possible layouts met the requirements of the brief: the boats could enter and leave through different sides of the building or through the same elevation. While solutions for the lower level were expected to be quite similar there were many possible solutions for the upper level; for example, roofs could be flat, pitched, arched or of irregular section, walls could be straight or curved, open or solid or a combination, and many cladding alternatives were possible. It was anticipated that the section of the building below ground would be of concrete construction but above ground level other materials could be used. It was hoped, since the building was in a theme park, that candidates would propose imaginative solutions for the superstructure. In relation to 'distinctness', two different building arrangements were expected, having different channel, queue area and access layouts.

Shallow foundations within the sand and gravel were appropriate, but candidates needed to take account of the effect of groundwater on the bearing capacity. Consideration also had to be given to the possibility of flotation and to the waterproofing of the basement area. The superstructure needed to have a clear span as internal columns were not permitted. As the elevation through which the boats exit had to be completely open, it was not possible to provide bracing to this elevation (unless provided externally to the building) and it was anticipated that some form of moment frame would be required. The open elevation also affected the wind loading.

In section 1(b) candidates were to explain the implications on the design of an increased groundwater level. They were expected to mention increased buoyancy (and possible solutions to overcome it) and increased lateral pressure on the basement retaining walls, and the effects on their design.

In section 2(c) calculations were expected for the basement retaining walls and floor slab, the foundations and main superstructure members: columns, beams and bracing. Section 2(d) drawings should have included as a minimum a plan at each level and longitudinal and transverse sections. Critical details could include waterproofing details and roof details. Method statements in part 2(e) should have considered dewatering, temporary support of excavations, and erection stability of the superstructure.

Candidates generally struggled to propose two significantly different solutions. The structural design of the basement was dealt with competently, although some candidates seemed unsure whether to use active or at- rest earth pressures for the basement wall. Some candidates also designed it as a propped cantilever but then produced method statements showing it being backfilled before the ground slab was constructed thus requiring it to act as unpropped. Waterproofing was generally not adequately addressed. The superstructure design was handled reasonably well, but solutions were somewhat unimaginative. Most candidates understood the implications of rising groundwater, but not all put forward suggestions for dealing with it.

The quality of the calculations varied significantly – some were very comprehensive, others were less so and omitted principal structural elements. For example, some candidates did not undertake any basement design. Very few candidates prepared elevations or longitudinal sections, the latter in particular being important in adequately conveying the scheme. Method statements were poor and were generally made up of a list of operations rather than an explanation of how the works were to be constructed.

Question 6: Administration building

The brief stipulated the design of a relatively straightforward building on reasonably good ground. The constraints were:

- a column-free atrium;
- a transfer beam needed at level 2;
- sloping ground;
- the site located in a game reserve a long way from the nearest town, and liable to flood;
- use to be made of local materials.

Unfortunately many candidates' handwriting was almost illegible and spelling was often poor. Many did not provide two distinct solutions, presenting consequent difficulty in justifying the selected option. Poor time management was also evident, and many candidates ignored important information in the question. Some calculations did not follow a clear logical process, and some drawings would be of little use to an estimator. Some superstructure solutions proposed were very heavy, such as deep beams and thick floor slabs, which were neither necessary nor appropriate. Many candidates simply failed to grasp the essence of the question. Nevertheless, there were a number of very good scripts!

In a game reserve, timber as a structural material should be readily available. A superstructure largely of masonry could also be appropriate, together with timber beams and floors. The use of a limited amount of concrete for key columns and foundations could be justified. The question clearly stated that steel was only available in very small quantities, but unfortunately a number of candidates proposed heavy steel superstructures which was contrary to the design brief and completely inappropriate. Heavy and/or large-diameter piled foundations were unjustifiable and unnecessary.

An acceptable option was a timber superstructure with pad foundations stepped to suit the sloping site so as to avoid deep foundations at the top of the slope. An alternative foundation could have timber columns embedded in 1m-deep pits filled with concrete for fixed feet, with the timber impregnated to suit the design life of the building and with appropriate maintenance access. Alternatively, packing with compacted stones or rocks could be used instead of the concrete fill. Columns could be located at partitions to give typical spans of 5m for beams. The dining room would need one or two internal columns to produce reasonable spans. Transfer beams would be required over the dining area for the offices above which are set back from the edge of the building. Stability could be provided by bracings or shear walls at partitions, with pinned feet columns. Alternatively the staircases could provide lateral stability in both directions thereby avoiding bracings within partitions. The roof could be of cut timber members spanning between the atrium void and perimeter of the building, with diagonal bracings. The roof ventilation timber structure could be supported off the atrium columns.

An acceptable alternative option was load-bearing masonry, timber floors and strip footings. The load-bearing walls would rest on stepped strip footings and provide lateral stability to the building. In-situ RC slabs with associated RC beams or RC frames could be justified but only on the assumption that a limit on the availability of steel in the question referred to structural steel and not steel reinforcement: a number of candidates stated that assumption in presenting a concrete solution. The roof structure could consist of two north-south timber trusses along the atrium void with transverse mono-pitched timber trusses.

In section 1(b), the main issues, identified by good candidates, were:

- with flood water depth increased to 3m, level 1 would need to be raised to provide sufficient height above highest forecast flood water. The resulting longer columns would attract greater lateral forces from wind and water thus increasing the size of columns and stability bracings.
- scour protection would need to be increased, together with perimeter channels to divert water from foundations.
- access steps would have to be increased and ramps may be required because of the height of level 1 above the sloping ground.

The implications of not raising the height of level 1 were that damage could be caused to electrical equipment and there would be hydrostatic loading on building elements. However, the design life of the building and its relation to the predicted climate change were not given so it was possible that the building might no longer be in use if and when flood levels rose.

Many candidates concentrated on the additional design fees and programme. Whilst these are important issues, the technical aspects should be the dominant feature of the letter.

In section 2(c), the typical key elements expected to be designed were: floor structure, primary, transfer and secondary beams, an internal and external column, confirmation of lateral stability via bracing or portal frames or shear walls, pitched roof structure, and foundations. A good number of candidates presented legible calculations that were easy to relate to the drawings and made good use of safe-load tables. Candidates need to include deflection checks as well as shear and bending checks. Those candidates who selected load-bearing masonry were expected to provide detailed calculations for both vertical loads and for lateral wind loads.

In section 2(d), drawings were required to provide suitable information for estimating purposes and some were of a good standard. However many candidates omitted sections, elevations or critical details. Several ignored the fact that the site sloped. Some drawings gave little information on member sizes. Details were often very limited and failed to demonstrate an acceptable knowledge of building construction.

The detailed method statement and construction programme for safe construction was mainly generic and not site specific. There were, however, some very good scripts demonstrating an understanding of construction practice with realistic timetables. As usual many candidates appeared to have left this section to the end of the exam when running out of time.

Site-specific issues included:

- no time constraint was given; however because of the distance of the site from the nearest town it would be advisable to fabricate off-site as much as possible.
- fencing was needed to separate animals from construction.
- power would need to be generated on-site as it is assumed that no services existed.
- foundations would be machine dug and the temporary stability of excavations in sandy gravel would need to be addressed.

- sustainability: construction wastage could be minimised by using modular dimensions to avoid off-cuts.
- consider proper storage of materials and equipment to avoid damage, plus having a surplus in case of damage or lack of fit.
- proposing a construction sequence and programme together with the level of resources and manpower to meet productivity targets.
- temporary bracings would be needed until structural frames were stable.
- external weatherproofing would be needed prior to internal fit-out.
- a construction period of approximately 6 to 8 months would be appropriate, but subject to manpower and the extent of on-site construction.

Question 7: New utilities module for an existing offshore platform

Candidates were required to design a new utilities module for an existing offshore platform. The module had to conform to the specified dimensional requirements, (L24m x W12m x H12m), and be hung off the side of the existing structure. A critical aspect of the brief was that the north supports did not align with the new module end truss, and that no internal bracing was permitted. Candidates were required to provide a structural configuration that would transfer dead and imposed loads through the module structural framing back to the supports on the existing structure i.e. the module top and bottom plans were required to support significant dead load forces as well as lateral and stability forces.

In section 1(a), solutions offered were braced, plated, or portal frame, ('vierendeel truss'), arrangements. Candidates are reminded that two distinct and viable solutions are required, and the structural behaviour of both solutions needs to be properly explained in words and diagrams. Candidates are expected to critically assess both arrangements and provide justification for their preferred solution. Satisfactory submissions recognised and gave due regard to the in-place and temporary conditions (loadout, transportation, lift, set-down and temporary hang-off). Solutions involving portal frames should have included some consideration of the large moments at the beam / column connections, especially in the transverse frame attached to the module's north supports.

The letter in section 1(b) asked candidates to look at the implications of adding a small crane in the southeast corner of the module. Most candidates identified the consequential increases in dead, imposed, wind and blast loads and the increased reactions at the module supports during in-place and temporary conditions. Also noted were the fatigue issues and the detail changes caused by introducing a crane pedestal into the module framing.

For section 2(c), generally insufficient calculations were presented to justify the sizing of the main structural elements. Consequently, many members shown in section 2(d) were sized by inspection only. The blast loads are significant and a blast truss would be required at all plan levels adjacent to the south face. Plan bracing within the rest of the module would also be necessary to transfer the blast loads to the structural supports. Candidates who relied on portal action to maintain the open space within the module should have calculated the magnitude of the frame moments as those due to dead and imposed loadings were very large, leading to massive structural sections that might make a portal solution unattractive in this instance. Candidates are encouraged to reconcile their initial dead load estimate with a final designed weight to confirm their calculations remain valid. Candidates must also allocate sufficient time to consider design of the supports for the in-place and temporary conditions.

In section 2(d), candidates were required to draw their structural arrangements, including critical details for estimating purposes. For an offshore installed 'hang-off' module, the critical details comprise the temporary supporting points, the permanent support points, the lift points and the inter-related details between the three. Further critical details were the joint and blast wall connections. Candidates are reminded of the importance of good quality sketches, drawn to scale, to clarify their design submissions and to identify the detailing necessary to maintain a viable arrangement. Single-line diagrams are not as useful, as joint eccentricities are not apparent and sensible design proportions cannot be verified by simple visual checks. The method statement in section 2(e) required candidates to describe the sequential steps involved during the transportation and installation of the module. One such step would be continual weather forecasting and monitoring, weather being the principal constraint for commencement of the sailaway and lift operations. An understanding of offshore installation is necessary as 'hang-off' module structures have to be lifted by a Heavy Lift Vessel, guided into position, hooked onto the supporting structure and rotated into position. Candidates should produce simple sketches to illustrate all significant issues during module installation, especially the interface between bumpers and guides on the new module and the existing platform. These operations have a significant bearing on all offshore structural solutions and may be the dominant design condition for the main frame members.

Question 8: Extension office building in an area of high seismicity

An additional office building alongside an existing one in an area of high seismicity was required. Positions of perimeter bracing were constrained by two exit points on the street façades, which had to be kept clear, and by access points into the existing building at levels 1 and 5.

Two fundamental seismic design issues had to be resolved: firstly, a viable lateral load-resisting system which provided adequate lateral and torsional stability had to be devised within the architectural constraints; secondly, the possibility of structural impact or other interaction between the existing and new buildings had to be considered.

There were two possibilities for the interaction problem. Either the new and existing buildings could have been joined together structurally, for example by devices that allowed thermal and other slow movements but which locked-up during an earthquake. One candidate suggested this option: it would probably have necessitated modifications in the existing building to balance out the distribution of seismic loads. During construction, this would have affected use of the building (likely to have been unpopular with the client) and in fact a convincing quantified scheme would have been difficult to prepare within the context of the CM exam, particularly since the floor heights of the two buildings did not match. Alternatively, the existing and new buildings could be designed as structurally separate, and a suitable gap between them provided to prevent pounding damage. Disappointingly, no candidate attempted even a rough estimate of what gap was needed. This would have been important for the design and detailing of the links between existing and new buildings. No-one observed that the existing building was unbraced, tending to increase the gap needed.

Given a structurally separate building, a braced solution to limit deflections was an obvious choice selected by most candidates. Finding an efficient layout of shear walls or cross braced frames that provided adequate torsional stability was not too difficult within the geometric constraints provided. It was also generally realised that the seismic forces arising in the projection of the building on the southeast corner could easily be carried back by the floor diaphragms to the main part of the structure, and candidates resisted the temptation to create two separate structures, each rectangular on plan, by putting in a structural joint. This would have created a rather slender second structure that might have been hard to make stable, with little corresponding benefit. Candidates who proposed as their alternative schemes shear walls or steel braced frames in the same positions were marked down as not providing sufficiently distinct alternatives. Overall lateral strength requirements varied between candidates from 11% to 24% of weight, a rather alarmingly wide range. The foundation soils posed no particular difficulty, and most sensibly chose a raft foundation. Another solution stopped off the bracing at ground floor level, creating a weak link between ground and raft, which would have been seismically vulnerable.

Section 1(b), the 'letter to the client' (always a stern test of fundamental understanding of structural behaviour) asked for the consequences of moving the access core and replacing it with a light-well. Candidates needed to consider the ways in which the move affected the centre of stiffness of the overall structure, and avoid creating torsional instability. Most candidates realised that shear walls were no longer possible around the light-well position because they would have blocked the light, although none pointed out that steel cross-bracing might have been acceptable to the client. In repositioning the access core candidates had to consider whether or not it was to be braced, and if it was, the effect of the new position on the torsional stability of the structure.

The 'seismic' question continues to be poorly supported, which is disappointing. We hope that more candidates will realise that a good earthquake-resistant design does not require an advanced analytical capability. Producing acceptable solutions for Question 8 should take no longer than for the 'non-seismic' questions. What is needed is a good grasp of the fundamentals of earthquake resistant design, rather than any fancy mathematics.

Associate Membership Examination 2010

Questions

1. Office development
2. Craft workshop
3. Retaining wall
4. Sports stand

Overview

Associate Membership Examination	2010
Total Candidates	33
Overall pass-rate	69.7%

Candidates were required to answer one question from a choice of four. As with previous years, candidates favoured two particular questions. Set out below are the key features of each question and general feedback on various sections.

Question 1: Office development

This question called for the design of a five-storey office development on a corner plot, with an enclosed area at roof level for plant and storage. The building elevations were to be of glass curtain walling, except for the elevation facing an existing retaining wall, which was to be of 260mm cavity wall construction. The sloping roof was to incorporate solar panels.

There were a number of key challenges, which included:

- The column spacing throughout the building had to be at least 6m, with only one line of columns permitted internally at all floor levels.
- No columns were permitted within the plant and storage area.
- The overall floor depth was to include a 150mm raised floor and a 400mm deep service zone between the ceiling and underside of the floor construction.
- No foundations were permitted beyond the building faces adjacent to the roads and the retaining wall.

Question 2: Craft workshops

In this question the owner of a canal required a new building to accommodate a restaurant, historical display area and 24 workshops. The ground floor was to contain the restaurant and display area. There were to be 12 workshops on the first floor, and 12 more on the second floor. Each workshop was to provide at least 7.5m by 7.5m of column-free space. A central 2m square hatch was required in the first and second floors to allow workshop equipment to be lifted off canal barges.

There were several key challenges, including:

- The building spanned the canal. The sides of the restaurant and display area facing the canal were to be glazed. As much natural lighting as possible was required for the workshops.
- The number of internal columns on the ground floor needed to be kept to a minimum.
- A clear floor to ceiling height of 4m was required at each floor. Floors were to incorporate a 500mm deep service zone. No part of the structure could be higher than 16m above ground level.
- No foundation or permanent structure was allowed within the 15m wide zone containing the canal and adjacent footpaths.
- The permanent structure was to leave clear headroom of 4m above ground level.
- The canal needed to be kept open at all times with 3m high clearance under any temporary works over the full 8m width of the canal.

Question 3: Retaining wall

This question called for the design of a retaining wall beside a section of new motorway. Typically, the wall was to be 5m high, and supported a new local public road running parallel to the motorway and aligned to suit the wall construction. A parapet was required along the top of the wall. The face and ends of the wall were required to blend with the natural surroundings.

The key challenges for this question were:

- The wall retained crushed rock fill having particular characteristics; namely: an angle of shearing resistance of 40° and a unit weight of between 18kN and 20kN per m^3.
- There was to be a 3.5m wide grassed verge at the base of the wall, next to the hard shoulder of the motorway.
- There was to be a similar verge, also 3.5m wide, inside the top of the wall between the wall and the public road. This verge was subject to a load of $10kN/m^2$.

Question 4: Sports stand

The question called for the design of a small stand on one side of a football pitch at a local sports ground.

The key challenges included:

- A roof was required over the entire area of the stand.
- The front and sides of the stand were to be constructed with the minimum of obstructions.

Feedback

Section 1(a)

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. A few instances occurred where candidates lost marks because they failed to provide an adequate design appraisal.

Section 1(b)

This section introduces a specific change required by the client that involves an additional structural engineering challenge. It is important that candidates recognise this challenge and deal with the structural engineering implications of the client change. Several candidates did not clearly outline the full structural implications nor how the client's request might be achieved.

Section 2(c)

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 own proposed solution is sub-divided into principal structural elements. Those candidates that gained low marks showed a need for better preparation and improved time management and exam technique.

Section 2(d)

Generally, this year, there was a reasonable standard of drawing. However, 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 the disposition of structural elements are drawn, along with comprehensive detailing, to meet this requirement and allow for adequate cost estimating.

Section 2(e)

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.