Examiners' reports

Membership (Part 3) and Associate-Membership examinations, April 1991

The examiners' reports are to be read with reference to the April 1991 question papers available from Publications at a price of £3.00 for members and £4.00 for non-members.

Part 3 (introduction)

The 1991 examination was attempted by 1110 candidates, an increase of 106 on last year's candidate figures. The overall pass-rate of 39.3 % was 1 % down on last year's figure, and it is somewhat disappointing to see the rate dip below the 40 % mark. The total number of UK candidates was 752, of whom 334 passed, a pass-rate of 44.4 %. The total number of overseas candidates was 358, of whom 102 passed, a pass-rate of 28.5 %.

By far the most popular question was question 4, a new office block within retained facades, where 166 candidates out of 450 passed, achieving a low pass-rate of 36.9 %. Question 1, a two-storey offices/production building was the second most popular, where 93 candidates out of 274 passed, achieving a low overall pass-rate of 35.2 %. Question 6, a lakeside bar/restaurant, was attempted by 173 candidates, of whom 84 passed, achieving a good pass-rate of 48.5 %. On the other hand, relatively few candidates attempted question 5, a rooftop swimming pool. Of the 51 candidates who attempted the question, 29 passed, achieving the highest pass-rate/question of 56.9 %. The bridge question, an opening footway/cycleway bridge, was attempted by 110 candidates, of whom 34 passed, achieving the lowest pass-rate/question of 30.9 %.

It is pleasing to see the continuing increase in the UK and overseas candidate numbers. It is hoped that the improvement in the pass-rate over the last few years, despite this year's slight drop, will see the overall pass-rate move upwards to the mid-40s mark and beyond.

As all Part 3 1991 candidates were aware, there was a highly publicised change in drawing paper size from A1 to A3. This decision to change was implemented by the Examinations Panel who recognised the need to conform more closely to contemporary office practice and typical design office conditions. This change has apparently been popular, judging by the few comments received.

The Examinations Panel wishes to make it clear to all future (and past) candidates that the change is not intended to downgrade the importance of drawing as one of the essential communication skills of an engineer. The preparation of clear drawings remains a fundamental element of the Part 3 examination.

The Chief Examiners have once more highlighted the following common areas of failure:

(1) Many candidates were clearly not ready for the basic examination requirements of both parts 1 and 2 of the question and would benefit from some examination preparation for future attempts.
(2) It is apparent that many candidates do not allocate their time sensibly, do not read the question with care, and do not present their written work clearly.
(3) Letter writing quality indicates the lack of candidates' experience in writing business letters, with too much technical language included rather than simple guidance for clients.
(4) Lack of ability or effort to address the structural implications and proposals for the problems posed in Part 1(b) of the question. Too many answers ignore the structural aspects and present information solely related to fees, claims, delays, and costs, usually culminating in the advice 'don't do it'.
(5) Failure to provide drawings with sufficient detail to justify a chosen solution and demonstrate adequate engineering judgments.

The change in paper size from A1 to A3 appears to have made little difference to the standard of drawings produced, and the change should not be an excuse for poor presentation.

Question 1

Some candidates gave alternative schemes in Part 1(a) in steel and concrete which had exactly the same structural layout. This is a poor approach, as both materials have particular aspects which should be used to advantage and expressed in each scheme. The use of the floor slab as a wind diaphragm was a common approach but little indication was given as to how this could be achieved, especially when using precast floor units. The question stated that certain areas were to be 'column free' but this was ignored in a number of cases. Other candidates used large spacings for perimeter columns and even clear span ground floor beams where this was not necessary.

Many candidates failed in Part 1(b) to write anything approaching a properly considered letter to the client. Many referred to delays, extra costs, extra fees, contract changes, etc., without outlining a technical solution to the client's request. While it is only necessary in Part 2(c) to carry out sufficient calculations to give sizes for estimating purposes, some consideration should be given to such aspects as deflection and vibration, especially where long spans are required.

Question 2

As with the previous question, the requirement for column-free areas was ignored by some candidates. This effectively changes the question and leads to a significant loss of marks. For the long-span roof, some chose an unsuitable RC solution, ignoring the requirement for service ducts, and some used lattice girders of insufficient depth. Many failed to consider the use of hollow sections to help keep maintenance low and provide an aesthetically pleasing structure. Calculations were often poor, omitting consideration of the effects of dominant openings, uplift and the provision of bottom chord ties and the deflection of long-span construction. The details asked for in this question required some knowledge of building construction which seemed to be beyond the scope of many candidates. The integration of the structure with other building components is an important factor for practising engineers to understand.

Question 3

The question called for the design of a combined footway/cycleway bridge to incorporate fixed approach spans and two central opening spans. While it was recognised that few candidates would have had the chance to work on an opening bridge, it was intended to test candidates' ability to apply their basic skills and appreciation of structural engineering to an unfamiliar problem. The question also offered candidates considerable opportunity to propose a range of structural solutions for the fixed ramps, together with various options for the opening spans. Very few candidates rose to the challenge of the conceptual design element of Part 1(a), showing little ability to think outside the more comfortable realms of normal bridge forms. Many candidates concentrated on the fixed ramps, choosing almost to ignore the 'too difficult' opening spans.

Part 1(a). Scripts which identified two viable options for both fixed and opening spans, discussed these in some depth, and addressed all the question's requirements, were awarded appropriately high marks. It cannot be too strongly emphasised that this part of the question is crucial, giving the candidate the best chance to communicate the wider conceptual design ability for which examiners are looking.

Part 1(b). Answers were generally of poor quality. Only a few candidates recognised that the change to a single larger opening could have a profound effect on the solution recommended in Part 1(a). The best letters discussed the implications of all aspects implicit in the question, i.e. cost, programme, structural form, construction method, appearance, restrictions to the passage of vessels during construction, late changes to design, etc.

Part 2(c). Candidates again seemed capable of producing pages of detailed and adequate calculations for areas of familiarity (e.g. prestressed beams) but not for all principal structural elements. Very scant calculations were given (if any) for substructures and foundations, and in some cases where cable-stayed bridges had been adopted, there were no calculations for the cables and towers. Stability of the opening structure was not well-addressed, nor was the effect of wind on the opened structure mentioned in many scripts.

Part 2(d). The change to A3 squared paper seems to have worked well and resulted in a more uniform standard to this part of the question. The smaller scales of the views for this structure may have resulted in less notes/dimensions being included on the drawings, and candidates should be aware that the drawings form a key element in the communication of their solution to the examiner.

Part 2(e). The supports to the opening span were very poorly attempted, reflecting candidates' lack of familiarity with moving, pinned bearings and perhaps lack of time and willingness to experiment. The more familiar ramp support was adequately detailed.

Part 2(f). Deficiencies in this part were probably due to candidates leaving themselves only barely adequate time to note the key basic steps.

Question 4

Structurally, this was a relatively straightforward question, and it was therefore important that all aspects of the design and construction were addressed. In some cases the soils data were taken to be from external ground level and not the basement level, as was clearly stated. This resulted in pad or raft foundations being offered with attendant problems. Where piled foundations were proposed, insufficient thought was given to the effect this operation would have on the facade which had to be retained. Very large diameter piles or driven piles were not appropriate. The limitation on structural depth was either ignored or miscalculated, and many candidates placed columns adjacent to the retained facade which clearly obstructed the window openings, contrary to the brief. Some candidates did not appear to appreciate that wide shallow concrete beams would be appropriate and therefore found narrow beams extremely difficult to justify. Solutions in structural steelwork tended to be uneconomic because of the limit on structural depth. Progressive collapse was frequently ignored. A number of candidates totally ignored the temporary works for the retained facade, which was clearly a very important element in this development and to which candidates' attention was drawn in the question. Among those who did deal with this, some proposals were too sketchy and others with raking shores neglected to deal with the horizontal force this geometry would impose. Also, wind forces were not considered. The drawings were for quantities to be measured and costs estimated but far too many did not have sufficient detail, no reinforcement estimate, no foundations, no section, etc. Many letters were confused and omitted to deal with the effects of water and the stability of the original brick retaining wall and its foundations. Too little time was spent on Parts 2(c) and (d) where marks were lost.

Question 5

Very few candidates attempted this question which had the attraction of not having to deal with foundations or building stability. Little imagination was expressed in the design of the roof, and some candidates totally ignored the grid of columns in the office block below, assuming that any load from the pool structure could be located anywhere on the slab. There were gross errors in the calculations, including omitting the weight of the water. The stability of the roof and enclosing walls was often not dealt with satisfactorily. In general, the new format of drawings was handled well, but some candidates produced very scrappy drawings and very little information. Drawings must deal with the various items required, such as plans at the various levels, sections and elevations. Frequently, the alternatives offered were not viable or not justified, with no indication of member sizes.

Question 6

The question called for candidates to design a lakeside bar/restaurant constructed partly in or partly over a lake. The client's brief for the single-storey building called for an elevational treatment in local masonry or timber. A number of superstructure solutions were possible, including framed infill structures and loadbearing masonry structures. The main aim of the question was to test candidates' ability to design a practical and robust foundation solution to provide a platform over the lake on which to construct the traditional building envisaged above. From the examiners' reports the question was thought to be a reasonable one, giving candidates considerable scope in the overall choice of solutions and materials. The obvious two solutions envisaged for the deck in or over the lake were as follows.

First, pile supported suspended decks with driven steel, concrete or timber piles, capping beams and precast/*in situ* beam and slab deck.

Secondly, steel sheet piles with stabilised land backfill with *in situ* concrete ground bearing or partially suspended raft deck, or a similar land-fill reclamation solution but without sheet piles.

Many candidates did not have sufficient knowledge of piling over water to do justice to piled solutions. Stability backing was often ignored, as was the possibility of using raking piles or anchorage foundations on land for the provision of lateral stability of the foundations.

Some amazing solutions were proposed, including vibrocompaction, draining the lake, sand bags, etc. Few candidates considered solutions involving cable-stayed support or cantilevering the platform over the lake to avoid construction in the water. Permanent anchor foundations or piles would have been necessary as would have been heavy temporary works. By and large, candidates were able to provide a variety of acceptable solutions for the building superstructure. The usual range of problems causing candidates to be marked down was encountered. These include inadequate consideration of alternative solutions, inability to communicate the load transfer and stability aspects of solutions proposed, poor quality writing, drawings and sketches, too many unnecessary calculations, inappropriate or heavy solutions.

Question 7

The quality of candidates' attempts was generally disappointing. There were few who demonstrated sound engineering appreciation in their scripts.

As all Part 3 questions, Part 1(a) is an illustrated design appraisal, and candidates should, in their examination preparation, consider how they will present this part of their answer. Two distinct and viable solutions were asked for. All candidates produced two schemes, mostly variations on trussed arrangements, some of which were well answered. However, some second options involved stressed skin/stiffened plate arrangements. It was clear that, in offering these options, the candidates did not really understand the principles involved. No consideration was given to load concentrations, such as those at module support points or lift points.

Some candidates did not offer two distinct and viable solutions, as the second scheme was a minor variant on the first with, perhaps, the truss braces inverted.

Little comprehension was shown of how to transfer loads efficiently through a structure to its support points. Often trusses were drawn between deck legs, but the truss braces did not pick up the module point loads, these loads being taken by bending in a very heavy top chord girder. Decks were given scant consideration, resulting in beams not spanning and distributing load efficiently. The temporary loading conditions were often not considered. For load out some candidates suggested using trailers under the lower deck level, not considering the deck legs which protrude down the deck. For the lift condition, lift points were not located with proper consideration of sling options (single hook, spreader bars, tandem lift).

Part 1(b). The letters to the client were poorly answered. Most candidates were over-concerned with their own costs and payments rather than advising the client on the structural implications of his proposals. Throughout all papers, nobody bothered to carry out a quick weight check on their proposed solution to see if the weight was in excess of the 2500 t weight limit given in the question. This section required the candidate to write about the impact of doubling the module loads. The main point to be realised here was that this would increase the deck structure weight and almost certainly exceed the 2500 t lift limitation. This may also put the modules outside the single hook lift and require tandem lift, which would then affect the analysis and installation costs.

Part 2(c). The calculation section required candidates to size principal elements. This was rarely achieved (e.g. main deck beams were often missed, trusses designed for inplace conditions but not lift). The lack of understanding of load paths and inefficient framing often resulted in very heavy designs. The drawings then reflected the inefficient designs. Often, not all truss elevations and deck plans were drawn.

Part 2(d). The standard of draughting and details can only be described as appalling. Engineers have to be able to transfer analysis/design requirements onto sketch sheets in order for detail draughtsmen or CAD operators to turn these into engineering drawings.

Part 2(e). The details were invariably poorly attempted. Candidates do not seem to allocate an appropriate amount of time on this section. Details were sketched which were often unsafe, with no thought of the load a plate or weld would carry. Details that could not be built were not uncommon.

Part 2(f). The final part of the question was either omitted or completed in such a rush as not to warrant many marks.

Associate-Membership (introduction)

The 1991 examination was attempted by 96 candidates, a decrease of 23 on last year's figures, which brings the number back to the low figure of 1989. However, the pass-rate of 77.1% is up on last year's figure by 0.6%. The most popular question was the steel question attempted by 41 candidates, with 32 achieving a pass.

The concrete question was attempted by 36 candidates, with 26 achieving a pass. The general question was attempted by 19 candidates, with 16 achieving a pass. Candidates performed marginally better in Part A than in Part B. Candidates must ensure that they complete all parts of the question, giving Part B equal attention to Part A, and that the effort and time given to each subpart is in proportion to the number of marks available.

Marking Examiners and assessors again stress the need for candidates to improve their examination techniques. The Associate-Membership examination is a unique exam for all candidates. Not only have many candidates been away from the examination situation for a number of years, but they are confronted with a much longer examination. The normal college examination of 3 h with five distinct questions to be answered is poor preparation for the AM examination.

It is hoped that the number of entrants will increase in the next few years and that they will continue a high level of performance.

There were no candidates for the oral examination this year: perhaps the keen minority of candidates has been catered for.

Question 1 (structural steelwork)
The question required the candidates to adapt an existing floor with the introduction of a new steel frame. The indications were that BS 449 is still a well-used Code, and candidates using it appeared to be better prepared than those using BS 5950.

Many candidates had a poor knowledge as to how the contractor would approach the problem and translate this into a method statement.

The details often demonstrated the candidate's lack of appreciation of the site construction problems.

Question 2 (structural concrete)
This question was related to the design of a retaining wall. Candidates who failed to satisfy the examiners amply demonstrated their unreadiness for the award of IEng in their drawing. While it may be that some candidates are familiar with CAD in their offices, they showed a complete lack of 'feel' for the work in their drawings.

That the examination is capable of being completed well in the time available is amply demonstrated by the candidate who scored 80% plus in both parts.

Question 3 (general construction)
An adaption of a building involving the use of several structural materials was the substance of this question. The work revolved around a new mansard roof to existing buildings to create further domestic accommodation.

In general candidates gave competent answers to the question, but weaknesses were shown in some cases. These weaknesses concerned the analysis of loading, the resolution of forces acting at angles, and an appreciation of the construction process.