Examiners' Reports

Part 3 and Associate Membership Examinations, April 1998

The examiners' reports are to be read with reference to the April 1998 question paper available from the Institution at a price of £3.00 for members and £4.00 for non-members

Part 3: Introduction

This year's examination was attempted by a total of 779 candidates, a slight increase in comparison with last year. Of those candidates, 379 took the examination in the UK while there were 384 candidates overseas.

A record number of 342 candidates took the examination at the Hong Kong centre and this was the first time that there were more candidates taking the examination outside of the UK.

The UK pass-rate was satisfactory: 167 candidates passed, producing a pass-rate of 43.5%. However candidate numbers have been decreasing over the last few years.

The Overseas pass-rate was slightly disappointing: 123 candidates passed, producing a pass-rate of 31.1%. The Hong Kong centre pass-rate was 31.6% which is lower than usual; however the number of candidates is very healthy and on the increase.

The overall pass-rate for the 1998 examination was 37.2% which although marginally better than last year is still below the more satisfactory 40% band.

Question 5 (city centre headquarters building) was the most popular and was attempted by 220 candidates, of whom 93 passed, achieving a pass-rate of 42.3%.

Question 2 (retail distribution centre) was attempted by 178 candidates, of whom 79 passed, achieving a pass-rate of 44.4%.

Question 1 (waterside office) was attempted by 197 candidates, of whom only 49 passed, achieving a low pass-rate of 24.9%. The Chief Examiner commented that many candidates did not address the implications of the canal and this significantly affected the pass-rate.

Question 3 (motorway overbridge) was attempted by 111 candidates, of whom 38 passed, achieving a pass-rate of 34.2%.

Question 6 (refurbishment of mill for cafe/ bar, shops and offices) was attempted by only 31 candidates, of whom 15 passed, achieving a pass-rate of 48.4%.

Question 4 (underground swimming pool) was attempted by 26 candidates, of whom 8 passed, achieving a pass-rate of 30.8%.

Question 7 (wellhead deck) was attempted by 16 candidates, of whom 8 passed, achieving a pass-rate of 50.0%.

The Institution continues to review all matters concerning its professional examinations including: the implications of SARTOR 3rd edition, maintaining and improving of all aspects of administering the examinations cycle, preparation advice and feedback to candidates, preparation course content and the training and development of marking examiners.

The Chief Examiners once again highlight common areas of failure among candidates:

(1) Candidates must answer the set question dealing with all the requirements stated in the brief. Candidates continue to change the question and often do not provide relevant information with regard to alternative schemes.

(2) Candidates must improve their examination technique, demonstrate time-management skills, answer all parts of the question and learn to express their engineering concepts in a clear and concise manner.

(3) The standard of candidates' drawings, detailings and calculations greatly vary in quality. Poor presentation, lack of communication and insufficient detail lose precious marks. The standard of A3 drawings has not improved since its introduction in 1992.

(4) Candidates' letters to clients and the method statements also greatly vary in content and quality. Candidates must practice compiling and writing good business letters which address all the clients' requirements.

(5) Candidates are in danger of losing the necessary skills to pass the chartered examination and develop as competent engineers in the work place due to the increasing use of computers in routine design and drawing work.

Question 1

The question required candidates to design a 3-storey office building which was 30m x 20m in plan with

a basement. The basement and ground floor levels were required to be 2m away from an existing canal with the upper floors cantilevering so that the building line was directly over the edge of the canal bank. Provision was also required to extend the office by an additional storey in the future. After the design was completed, the client requested that a 10m section of the basement facing the canal be flooded to form a boat house and candidates were asked to consider the implications of this request. The question was designed to test the candidates' ability to deal with a foundation problem as well as a routine superstructure scheme.

The superstructure design was well attempted by most candidates although a relatively small number did not consider the requirement of progressive collapse if a further storey was added. The problems of the basement construction were also treated in a workmanlike manner by many and a number of buildable schemes were developed. Unfortunately, there were some who completely ignored the problems of water and there was one candidate who proposed excavating behind the canal without any form of support.

The Graham Wood prize was awarded to one of the candidates who attempted this question. This candidate stood out as one who considered each aspect of the question in detail and provided cogent and workable answers to each section.

Question 2

The question invited candidates to design a 50m x 60 m retail warehouse with office accommodation in which the client would permit a single internal column. In particular, candidates had to consider the problems associated with a sloping site and the need to locate the building in an excavation adjacent to the site boundary. Restricted to the adjoining site meant that some form of contiguous piled wall would be required to retain the boundary. Candidates were required to advise on the form of the wall but not to design it.

The superstructure part of the question was, as expected, well-attempted by the majority of candidates who produced reasonably economical and well-proportioned solutions. The treatment of foundations did, however, cause some problems. The retaining wall solutions offered by many candidates required either excavation into the adjoining site or a large foundation toe which clashed with the new building foundations. The advantages of a form of bored pile wall in terms of programme and neatness of construction were mentioned by only a few. Many candidates also got into difficulty with the building and floor slab on the variable ground conditions caused by site levelling.

As in previous years, the steelwork examiners noted a poor standard of sketch drawing and an inability to perform outline structural calculations. Very few candidates demonstrated the ability to propose a workable scheme with supporting sketches of adequate quality, calculations and comment. This is a consequence of computer-aided design and draughting within the industry.

Question 3

The question required candidates to consider the design of a bridge to carry a minor road over a new section of dual 3-lane motorway located in a deep chalk cutting. The following are key features of the question.

The specified clearance envelope dictated that a minimum clear-span of about 43m was required. The appearance of the bridge was an important design consideration. Due to the depth of the cutting, the construction depth available for the bridge did not present a restriction on the form of structure. The bridge could be entirely founded on chalk.

The question gave candidates the opportunity to identify two options from a wide range of interesting and aesthetically pleasing structural solutions, including arches with and without spandrel columns and portal frame structures with inclined column supports.

In the event, many candidates proposed 3-span structures with vertical piers. Whilst this was disappointing to the examiners, such proposals were deemed to be an acceptable solution. The examiners were, however encouraged to see some interesting arch and portal frame designs proposed by those candidates who gained the highest marks. Most candidates who proposed 3-span solutions opted for beam and slab construction for the superstructure using either steel plate girders or precast, prestressed concrete beams.

Some candidates proposed single-span solutions by locating 20m high abutments adjacent to the clearance envelope. These solutions did not generally impress the examiners who felt they were inappropriate for the site. As the bridge could be founded on chalk it should have been possible to design most forms of structure to be supported on simple spread foundations. The examiners noted that some candidates proposed unnecessary use of piles, with pile caps which were large enough to have actually worked as spread foundations on chalk.

In Part 1a, some candidates simply proposed two similar 3-span structures, one in concrete and one in steel. Bearing in mind the wide range of possible solutions this approach suggests a lack of experience and understanding of the problem posed.

In Part lb, for candidates proposing a three span design, it was important to identify the design changes that would be necessary to deal with uplift at the end supports due to the shortening of the end spans.

In Part 2c, calculations tended to centre on the design of the superstructure, with insufficient attention given to the substructure and foundations. Candidates needed to deal with all parts of the design to gain the maximum marks. In relation to the substructure, some candidates who chose 3-span designs did not mention the slenderness of the 20m high piers.

In Part 2d the examiners were looking for, as a minimum, a plan, an elevation and at least one section through the bridge for estimating purposes. Some candidates did not show all of these views. In addition, it was noted that many candidates did not include sufficient dimensions on the drawings, particularly for the substructure elements.

In Part 2e the details of a typical connection between 2 primary structural elements and the detail of an end support were generally well attempted.

In Part 2f most candidates identified the best way to construct their proposed design. Few candidates addressed the construction of the foundations especially at the base of the cutting.

Question 4

An underground swimming pool was required in the garden of a residential mansion. At the heart of the question was the need to provide a sound watertight enclosure which would not float when *the pool* was empty and which would sustain the various lateral and vertical loads imposed on it.

The broader aspects, which offered candidates scope to demonstrate their experience and ability to deal with practical constraints, included limited working space, restricted site access and environmental concerns.

The question focused towards a domestic scale, aimed at minimising both the volume of excavation and the size of plant employed. Many candidates appeared unable to adapt their thinking to this level and, too often, oversized excavations were proposed that would have been costly, difficult to undertake and would have risked legal action by neighbours in defence of their privacy.

Successful candidates proposed a 'concrete box' solution, with *in situ* walls spanning vertically between ring beams, and with a wide variety of roof structures. Exclusion of groundwater by light sheet piling was a sensible method. The quality of drawings was often poor, suggesting candidates lacked experience in their production, and the detailed sketches and method statement were not well done, with safety aspects being almost entirely ignored.

Question S

A new 8-storey building, circular in plan and with a central core as the single main structural element, was required on a very constrained site in a city-centre.

Allowances for structural depths of floors were generous and at least three viable solutions were proposed by candidates: cantilevering each floor directly from the spine, hanging the floors from steel trusses at roof level, and supporting all floors on perimeter columns, in turn supported on the first floor, cantilevered from the core.

The first of these was probably the most successful. Candidates offering the last solution ran into increasing difficulty with the size of their first floor cantilevers and their connections with the core. Proposed core wall thicknesses varied considerably.

The use of piles was the only reasonable overall solution for the foundations, but successful candidates were able to offer several variants of layout and size.

Several candidates breached the fundamental requirements of the question, in some cases rafts above the tunnels were offered as foundations. These imposed substantial loads on the tunnels, and perimeter columns between the ground and first floor were provided by some candidates in contravention of the brief.

This question sought to explore two areas in detail. The first was to test candidates' understanding of cantilever action, as a development of a question in the 1997 examination where a high proportion of candidates succeeded in designing a cantilever but failed to design the structure to which it was attached. There was little improvement to report this year.

The second aim was to distinguish clearly between candidates, rewarding those who were able and willing to develop appropriate solutions in response to the question and penalise those who attempted to fit pre-prepared solutions to the question regardless of relevance.

Their clients were poorly served by the many candidates who offered flat-slab and beam-slab solutions as alternatives and who appeared unable to distinguish between this cylindrical cantilever structure and the typical multi-bay multi-floor rectangular concrete building with which they were evidently more familiar.

Few candidates appeared to be aware of the structural effects of earthquake forces and the methods of combating them, and were consequently unable to provide constructive advice to the client. Drawings and details were poorly done, and indicated candidates' lack of experience in preparing working drawings by hand.

Question 6

A derelict mill building was to be refurbished for a cafe/bar, shops and offices. The conversion required removal of the first floor structure and the ground and first floor storey cast iron columns over about a 12m x l2m area in the western half of the building. It also required the opening up of the undercroft to create a basemeant restaurant and kitchen. The existing second floor therefore needed to be supported over the 12m x 12m cafe/bar area, to enable this upper floor to be used for offices. Lateral restraint of the existing side and rear external wails was required where the first floor was to be removed for the café/bar and the overall stability of this area needed to be addressed in the remodelled scheme.

In Part la most candidates proposed steel beam support solutions with the two alternative schemes varying in many scripts only by the change in direction of the span. These steel beam grillages were supported on either existing brickwork and new stanchions, where appropriate, or on an new internal steel frame. Several alternative solutions were offered, with steel trusses, in some cases occupying the entire height of the second storey. In the latter case, internal partitions through the offices were created in the planes of the trusses. Whilst a support system occupying the second floor storey was not envisaged, neither was it precluded. However, such solutions were marked down where the flexibility of the office accommodation was compromised from its original open plan nature.

To create the basement, kitchen and restaurant, underpinning of the front internal substructure wall was required, most appropriately by casting mass concrete blocks in short lengths. Partial removal of, or at least the creation of, large openings through the rear internal substructure wall was also required. New foundations and underpinning were either on to mudstone (although dewatering would be required at this depth) or into the stiff clay (where they would have to be wider, to limit differential settlement). These aspects were generally addressed well.

In Part 1b some candidates did not sufficiently address the potential posed by the fire (the weakening of structural elements, instability, etc) and considered it more important to mention fees. Whilst commercial activities are important to any structural designer, this examination primarily tests the technical ability of the candidates.

In Part 2c calculations for the necessary range of structural elements were well presented, though they were frequently lacking in a logical progression of elemental design. Calculations could generally have been better set out and have been more self-explanatory.

In Part 2d the general standard of drawing to provide the necessary information for estimating was not high. It is apparent that the candidate who is able to produce good clear drawings and sketches will generally produce a good script, whereas the same cannot always be said for the candidate producing good calculations.

In Part 2f the relatively poor attempt at a method statement demonstrates many candidates' inability to allocate their time to all the sections in the examination.

Question 7

The wellhead deck is a structure supporting facilities for gas production. The deck support structure was to be installed separately from the deck.

The arrangement of this structure allowed the candidates to determine how the deck was to be supported. The deck structure was to be open suggesting minimal internal structure and truss steelwork. The location of the sub-structure, together with the helideck, cantilevered to the West meant a centre of gravity offset from the centre support. The blast-loading requirement was a significant horizontal load to be considered in the in-place condition.

In Part 1a the presentation of two viable structural concepts were requested. These could have different support arrangements to the deck and alternative deck truss configurations.

Part 16 asked the candidate to discuss the effect on the design of increasing the blast loading by a factor of 2. This meant that the already sizeable loading was doubled, and therefore required the candidate to consider the necessary strengthening measures.

Part 2c required candidates to provide for a sample of the main structural elements. Some of the candidates had difficulty in assessing the critical load conditions to consider in the limited time available.

Part 2d required the drawing work to present the concepts as defined in the earlier sections. The marking reflected both the presentation of the structure as required for estimating purposes and also the adequacy of the input from the concept and calculation sections of the candidates' response. For example, an inefficient structure, will not be given as high marks as an efficient structure, albeit presented in a similar manner.

Part 2e required some typical details to be drawn. Some brief back-up calculations were usually poorly attempted with often unworkable designs presented.

Part 2f required some brief demonstration of the candidates' practical experience, and that they had some knowledge of how his theoretical design may be converted into a real, efficient and safe structure.

Although the offshore question is set in a specialised field of structural engineering, it is intended to assess a candidates grasp of structural design and not a knowledge of offshore practice.

Associate-Membership: Introduction Only 42 candidates attempted the 1998 written examination which is the lowest number on record. Since 1994 the numbers had been more or less constant at 50 candidates per year. This year's overall pass-rate was 54.8% which is also well down on the last few years, in fact the lowest figure since 1983.

No award of the Dennis Matthews Prize was made as it was considered that no one script was of a high enough standard to merit the award. There were no overseas candidates. The format of the examination question paper was unchanged and required candidates to answer one question from a choice of three.

Over half of the candidates (52.3%) attempted the structural steelwork question in contrast to the concrete question which only three candidates (7.1 %) attempted. The general question was attempted by 40.6% of candidates. It was considered that the low number attempting the concrete question in part reflects the type of design office experience currently being obtained by candidates which is better suited to the other questions.

Potential candidates should be aware that from 1999 onwards a bridge question will be added to the Associate-Membership written examination paper. The format of this question will be similar to the three existing questions.

Structural steelwork

This question concerned a 4-storey office block with a cantilever at first floor level. In part A candidates were required to design beams, a column, bracing, a base and to prepare detailed drawings including main connections. In Part B questions were included on quantities, specifications and site erection.

Generally, element design was carried out satisfactorily. However, the preparation of suitable drawings, and in particular connection details within the time limits imposed by the examination again proved to be a general problem.

Part B was generally tackled competently by those candidates that allowed sufficient time for this part of the examination. It was apparent, however, that several of the failed candidates ran out of time.

It is important for all candidates to allocate a reasonable proportion of the time available to Part B. A few of the Branches hold examination preparation courses which can be an invaluable aid to examination technique. Candidates should also study and digest 'A reminder from your Examiners' at the front of the paper.

Reinforced concrete

An external cast *in situ* reinforced concrete access ramp supported by cross-head beams, off a central line of columns, was the subject of this question which did not prove to be a popular choice with candidates. As usual in Part A, candidates were tested on the design and detailing of structural elements. Part B, in the main, concerned site related and specification topics.

Generally the standard of the answers was poor, particularly on the design sections and the failure of candidates to appreciate that the slab should be considered as 2-way spanning and therefore taking no account of the edge upstands other than the additional dead load. This required the slab to span 6m in one direction and in a heavy and uneconomic design.

In Part B it appeared that in some cases candidates had wasted time copying out standard specifications and details without reading the question properly.

General construction

This question concerned the alteration and basement extension of an existing Assembly Hall including a new mezzanine floor and pitched roof. In Part A designs were required in timber, structural steelwork, masonry and reinforced concrete. Details in these materials were also required. In Part B as for the other two questions, specifications and site matters were the main topics examined.

As in question 1, several candidates having achieved a pass mark in Part A appeared to run out of time and therefore failed Part B, and consequently the examination.

In Part B it is important that clear annotated sketches are provided when requested in the question to avoid losing marks. Also sketches can be used to clarify written answers even when they are not specifically asked for in the question.

Associate-Membership Oral Examination

This route remains available to candidates not less than 35 years of age with the required minimum academic qualifications and suitable experience. During the year five candidates, an increase on previous years, were examined based on submitted projects. It reflects the general high standard of candidates that all five were successful.