Examiners' reports

Part 3 and Associate-Membership examinations, April 1996

The examiners' reports are to be read with reference to the April 1996 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 763, a decrease in comparison with last year and the lowest figure since 1984. Of those candidates, 404 took the examination in the UK while there were 359 candidates overseas, 293 at the Hong Kong centre. The UK pass-rate dipped below the 40s level at 39.6% which is down 12.1% in comparison with last year; however, there were 58 fewer candidates. The overseas candidate figures are largely made up by the Hong Kong centre and 32 other centres. The total number of 359 is represented by an increase in Hong Kong of 21 candidates and a decrease at other centres of 18 candidates. The Hong Kong pass-rate saw a small increase to 34.1%; the other centres managed 11 successes out of 66, a pass-rate of 16.7% and a small decrease from last year. The overall pass-rate was 35.5% which represents a decrease of 6.1% from last year's figures.

Question 5 (city centre office building) was the most popular, which was attempted by 405 candidates (53.1% of all candidates), of whom 145 passed, achieving a pass-rate of 35.8%. Question 3 (river footbridge) was attempted by 110 candidates, of whom 42 passed, achieving a pass-rate of 38.2%. Question 1 (research building) was attempted by 78 candidates, of whom 27 passed, achieving a pass-rate of 34.6%. Question 6 (library extension) was attempted by 69 candidates, of whom 24 passed, achieving a pass-rate of 34.8%. Question 2 (exhibition and function building) was attempted by 45 candidates, of whom 15 passed, achieving a pass-rate of 33.3%. Question 4 (pumphouse) was attempted by 33 candidates, of whom 10 passed, achieving a pass-rate of 30.3%. Finally, question 7 (link bridge module) was attempted by 23 candidates, of whom eight passed, achieving a pass-rate of 34.8%.

It is somewhat disappointing to see the candidate figures decline following a slight upturn with regard to last year's figures. It has been mentioned earlier that the UK figure has decreased by over 50, and this cannot be entirely explained by the continuing economic climate. The Hong Kong candidate figure nearly touched 300. The Examinations Panel, on behalf of the Institution, is liaising with the appropriate people in Hong Kong and China to ensure that their local requirements are more reflected within the Part 3 examination. The panel, however, agrees that a specialist or specific question with an added insert containing local conditions is not feasible. It is felt that any such move would affect the general international nature of the overall question paper. The Part 3 Chief Examiners will be closely examining the wording within the text for next year's question paper in order to keep it generalised, unambiguous, and using nomenclature which is recognised worldwide. The panel continues to monitor the development of a 'distance-preparation package', undertaken by the Lancashire & Cheshire Branch. The idea of the package is to provide a number of modules relating to each part of the examination.

As in previous years, the Chief Examiners have commented on areas of failure that are common to all candidates:

(1) Many candidates lack ability in conceptual engineering, basic drawing skills, dealing with client problems, and show weak examination technique.
(2) The standard of drawings remains unsatisfactory in respect of quality and quantity. Candidates in future should address these points and consider also what information needs to be shown on drawings.
(3) Candidates appear not to be involved in letter writing at their places of work, and future candidates need practice or guidance in this respect.
(4) Candidates must read the question very carefully and understand all aspects of the client's brief. As in previous years, alternative schemes were often insufficient in variation of materials and structural form.
(5) Many candidates do not receive adequate training, perhaps because of the excessive use of computers in calculations and drawing work. This prevents young engineers from developing the skills necessary to become competent engineers and pass the examination.

Question 1

The candidates were asked to consider the design of a large open building 80m × 80m in plan and with a clear headroom of 30m. Provision had to be made for a three-storey demountable office which could be erected internally along any of three walls. A large door was provided for in the fourth elevation. The question asked candidates what their recommendation would be if the demountable offices were to become permanent with an increase in floor loading.

A number of candidates did well and answered all sections. On the whole, however, the question was not well tackled. Although a restriction was not given on the number of internal columns, many candidates simplified the question unduly by providing many of them. Wind loading, deflections and large spans presented difficulties for many who appeared unable to convert elemental design into a workable building structure. The standard of drawings was generally poor, often not adequate for basic measurement.

The problem of upgrading the demountable offices was poorly tackled by some. Too few candidates gave the client sensible engineering answers. One candidate effectively told the client to scrap the offices and start again; another said that they just happened to be overdesigned and that no alterations were necessary.

Question 2

The question concerned a 50m diameter exhibition centre linking with a rectangular two- storey office. The question did not specify whether or not columns would be permitted within the exhibition centre, and candidates were expected to take into account the use of the building in deciding on this factor. A high groundwater table was present. During the course of foundation work the client requested that the office be made column-free.

Many candidates produced workable solutions, either providing a column-free exhibition centre or by specifying a single central column. A number of candidates, however, were unable to produce a structure which covered a circular plan area; some provided excessive bracing, others none at all. Several candidates produced imaginative schemes to render the office column-free, although many were unable to produce any solution. One told the client that the request was impossible.

Question 3

Candidates were asked to design a footbridge across a river. The significant aspects were the relatively long span, the poor ground conditions at shallow depth, and the narrow width of the bridge in relation to its span. The substructure restrictions in the river created a minimum central span in excess of 60m.

The format of the bridge framing had many possibilities, including three-span steel or concrete beam decks, through girders, steel trusses, and cable-stayed structures. A number of candidates proposed single-span structures over 100m long using steel trusses up to 10m deep and having most ungainly proportions. The erection difficulties of these proposals were rarely addressed adequately.

In Part 1(a), candidates proposed a wide variety of structural forms, span arrangements, and materials. There was, however, little mention of the potential hazards from scour, debris in the river or vibration sensitivity of long-span footbridges.

Part 2(b) asked the candidates to consider the effects of a maintenance vehicle using such a bridge. Many candidates wrongly concluded that this vehicle would have a major effect on the overall design of the bridge and failed to see that the effects would be localised to the areas directly subjected to the high wheel loading. The vehicle could also affect the proposed parapet used and access control to the bridge. The letters were, however, reasonably well presented.

The calculations were generally inadequately detailed, and many candidates did little or no

design on the substructure despite the specific requests for this in the question. Design errors noted by the examiners included failure to consider the lateral stability of compression members in the top boom of a truss, failure to spot the risk of bearing uplift at the end support of a continuous bridge, and little consideration of the likely vertical and horizontal deflections.

The drawings were generally satisfactory, although some candidates omitted important dimensions, bracings, and other ancillary information. The sketches were poorly presented by many candidates, with little detailed consideration other than showing typical standard details not specific to the question. The method statements were reasonably prepared, although the consideration of temporary works was not well detailed by all candidates.

Question 4

This question was the more specialised of the two concrete questions and required the candidate to be familiar with the design of water-retaining structures below ground level.

The pumphouse building was quite simple in form and clearly in itself was secondary to the main design consideration which was the wet well structure below. Some candidates completely ignored this and produced solutions covering only the design of the single-storey building structure. Clearly, candidates must carefully read and understand the client's brief before rushing into producing their solution.

The preferred solution was either (a) a top-down construction for the wet well utilising diaphragm or secant pile walls as temporary works or (b) bottom-up construction utilising a temporary cofferdam for the construction phase. Dewatering was also considered necessary to construct the works but some candidates failed to appreciate the need to consider the flotation aspects of the structure in its permanent condition. Calculations were expected to be produced to determine, firstly, whether buoyancy of the structure existed and, secondly, how the structure would resist the upward loads generated.

The majority of candidates dealt with the main issues arising from the possible introduction of an additional storey to the pump house. Few candidates demonstrated their ability to put the points down in the style of a letter as requested.

In Part 2(c) many candidates put too much effort into designing the superstructure, with minimal calculations provided for the wet well substructure. The drawings and sketches were variable in quality with very few candidates producing sufficient information to enable material quantities to be produced for estimating purposes. Most candidates appreciated the need to dewater the excavations during the construction phase, although the use of well points alone was not considered viable owing to the close proximity of the sea. Sealing of the structure into the underlying clay was considered more appropriate.

Question 5

This was a fairly straightforward question which encompassed many of the factors and constraints normally encountered in everyday situations. The constraints on this particular site were identified and included the existing culvert, the retained facade, and the restricted site access for constructing the works. In addition, the client specifically required that internal columns must not be less than 10m centres. Therefore, the restriction on access generally led to the preferred solution being in *in situ* reinforced concrete rather than precast concrete or structural steelwork. Although the latter was possible, clearly how the candidate intended to transport the steel members to site in terms of member length, site splices, etc., needed addressing.

As far as solutions in reinforced concrete were concerned, most candidates chose flat slab, ribbed slab or wide beam solutions. Candidates should understand that alternative solutions must be distinct from one another and minor differences between solutions, such as planning slabs one way rather than two way, will not attract many marks. The disposition of columns outside of the existing culvert also required some detailed thought by candidates, particularly with regard to the foundations. Some candidates failed to recognise that, whilst they had positioned the columns each side of the culvert, the supporting piles and pilecaps clashed with the existing structure.

Letters to the client in Part 1(b) were generally poor and did not address what effects the client's proposed change would have on the structural layout in terms of simplification, etc., and delays which could result from the redesign of the works were not mentioned in many cases.

Although calculations were generally acceptable, in most cases they were insufficient and did not include all principal elements. Clearly, candidates are spending too much time on designing floor slabs rather than allocating their time more efficiently to include main beams, columns, foundations and retaining walls where applicable.

The question required that sufficient information should be included on the drawing to allow an estimate to be prepared for the works. In some cases, far more information than necessary is shown on one particular aspect rather than the required general overall dimensional plans and sections to enable material quantities to be prepared. The sketches required in Part 2(c) were generally very poor and showed a lack of knowledge in producing good or workable building details.

The method statement was similarly poor, and few candidates appeared to have any previous experience producing information of this kind. Few candidates appreciated the need to produce a method statement that would allow the engineer to inspect the existing foundations in a safe manner.

Question 6

An extension to a city centre library was required, building immediately adjacent to two wings of the existing building. The extension was to be primarily two-storey, although the main part was to have a mezzanine first-floor, and a partial basement was required. The front elevation was to be in glass, with the remaining elevations of cavity masonry. The reading areas (specifically written) were to have a clear span roof. Ground conditions were typical of inner-city redevelopment sites, with made ground, albeit overlying suitable bearing strata at relatively shallow depth.

A solution in any structural material(s) complying with the brief was sought. As the basement would be founded in the mudstone, it was envisaged that the whole extension would be founded in that strata. The superstructure required framing and the question directed the candidates to a line of roof support for the frames 1.5m away from the existing library and museum, with support for the mezzanine at the ends of the bookshelves. With this, negligible load would be transmitted to the existing building.

In Part 1(a), most candidates proposed steel framed solutions for the external shell, although some chose timber and a few concrete. The floors were mostly framed with concrete or steel, with *in situ* or precast concrete decks, and some solutions offered timber joists on steel beams. Candidates who offered heavy or less appropriate solutions were marked down. Most solutions adopted shallow foundations, but a few candidates chose piles or ground improvement techniques. However, many did not consider differential settlement. Where the rafters (and in some cases floors) were to be supported by existing walls, most candidates did not address the need to appraise the existing structure and the need for underpinning; these were marked down. Also, many did not address differences in consolidation settlement between types of founding stratum.

In Part 1(b), most candidates recognised that unless the basement walls were positioned away from the existing building, it would need underpinning. However, the general standard of letter writing was poor.

In Part 2(c), generally calculations were poorly set out and lacked sufficient detail, although fewer candidates failed here.

In Part 2(d), the reducing standard of drawing of perhaps the majority of candidates is an area for concern. The key words 'for estimating purposes' should have directed the need for solutions to be presented clearly and concisely in drawn form, with sufficient information depicted; most candidates did not. Part 2(e) was not well answered, with many candidates displaying insufficient experience of construction details.

In Part 2(f), the key words 'safe preparation/construction and (minimising) disruption' gave candidates an opportunity to demonstrate their knowledge of building legislation and safety in construction, and to address buildability, construction processes, and temporary works. Even with the last section often completed in haste, many candidates gained valuable marks by demonstrating their knowledge of some of these important aspects.

Question 7

The overall percentage pass-rate for this year's question was disappointing for what was essentially a straightforward question. For the prepared candidate, the only point that needed clear thought was at support marked 'c' which effectively was a single point bridge-type bearing. The general standard

was such that no prize was awarded for an exceptional script.

In line with other years some candidates failed to read the question fully, the interpretation of a single lift was not universally understood, and the lift weight limitation was generally ignored, resulting in candidates being marked down. The layout of the structural framing was not clearly shown, particularly with respect to lateral bracing configuration.

The client's requirements, although clearly stated, appeared to cause difficulty in positioning the crane to suit the chosen layout. The drawings, as usual, were poorly laid out and of a very poor standard. From the structural details, in most cases it was clear that candidates had very little knowledge of joint design or fabrication experience.

The key to passing this examination is preparation and timing. It is clear from all candidates that marks are lost because the design is too detailed and candidates leave insufficient time for the remaining parts of the paper.

Associate-Membership: Introduction

The number of candidates who attempted this year's examination was 49, one less than the previous year, numbers remaining disappointingly low. The pass-rate was 69.4% which is a decrease of 8.6% compared with last year. Two overseas candidates took the examination in Johannesburg; both were successful. The structural steel question was attempted by 10 candidates, with a 100% pass-rate. It was felt that these candidates probably had some speciality in this field. The structural concrete question was attempted by seven candidates, of whom three passed, a pass-rate of 42.9%. The general construction question was the most popular, attempted by 32 candidates, of whom 21 passed, achieving a pass-rate of 65.6%.

In general, candidates gained higher marks in Part A than in Part B. It is most important for candidates to realise that they must satisfy the examiners in both parts of the question and that time should be allocated appropriately.

The failed candidates who attempted the concrete question showed an overall weakness in satisfying the examiners; those who failed the general question did not adequately deal with a variety of structural elements in different materials. Unusually, there were no failures in the steel question.

The Denis Matthews Prize was awarded to Mr N. J. Antal who achieved the highest aggregate marks obtained in the examination.

Structural steelwork

This question concerned the design of a steel framed infill structure built over an existing loading bay area to a shopping centre. In Part A the candidates were required to design several of the structural elements including the clear-span girder at roof level and to prepare detail drawings. In Part B the candidates were tested on specifications, cladding aspects, and site procedures.

Generally, the question was answered competently by the candidates, although the quality of drawings and calculations ranged from very good to just adequate to achieve a pass.

Structural concrete

This question required candidates in Part A to design and detail elements of a freestanding, elevated water-storage tank and in Part B to answer questions on specifications, finishes, and site activities.

Generally, this question was poorly answered. Some candidates displayed a poor appreciation of structural behaviour, stability was hardly considered and neither was slenderness of the supporting columns. Overall presentation, with one exception, was poor to mediocre. The presentation and quality of drawing was below the normal standard of recent Associate-Membership examinations.

General construction

The question depicted a typical solution where a client wished to provide an extra floor in an existing high-level building. The question was fairly well answered but it was surprising that so many candidates failed to recognise the significant tensile force in the bottom chord of the truss. Consequently, the repair and proposed temporary works were mainly unsatisfactory. Many valuable marks were lost in these instances.

Most candidates could not design a simple splice connection for a steel beam but were aware that it was preferable for the splices to be located at points of contraflexure. Some candidates failed to provide top and bottom flange plates to accommodate bending moment variations at these points and were penalised. One candidate opted for a piled solution, even though the question clearly stated that a new RC foundation was required, and again was marked down. Several candidates offered potentially unstable structures, and one elected to provide compressible material under the existing masonry walling. Other candidates were not aware that the stanchion effective length should be at least 1.5 but could be 2.0 and again were marked down. The structural details were generally fairly well presented.

Associate-Membership oral examination

There was only one oral candidate this year, who was successful. This route to Associate-Membership remains a viable alternative to the written examination for those with the appropriate experience and qualifications.