



## Annexure 1 - Key Attributes

### Introductory Remarks

1. The key attributes outline the basic competence required of candidates pursuing accreditation program of Accredited Structural Engineer. Achievement of the attributes is expected to ensure that the Accredited Structural Engineer has a sound and broad based upon which, further professional and managerial capability can be built.
2. The key attributes relate to all types of structural engineering work and associated disciplines, indicating, by-and-large, only the minimum standard of required competence. Objective and progressive assessment is the basis to measure achievement, rather than only the time-served.
3. The key attributes are arranged in three sections :

**Engineering:** identification and solution of engineering problems and the safe, economic and sustainable implementation of the solutions.

**Management and Commercial:** efficient procurement and management of resources within economic, environmental and regulatory constraints to achieve the engineering objectives.

**Personal:** effective communication, interpersonal skills and professional commitment.

4. The Initial Professional Development (IPD) for candidates intending to qualify as Accredited Structural Engineers of the Indian Association of Structural Engineers (IAStructE) will be required to demonstrate the minimum level of competence in each of the attributes within their chosen career path.

The minimum expectation from a candidate vis-a-vis the key attributes has been placed at the following four competence levels:

**Competence Level 1** : General appreciation of the subject, as well as an understanding of how this may affect, or integrate with other associated subjects.

**Competence Level 2** : Knowledge and understanding of the subject and its application.

**Competence Level 3** : Experience of practicing the subject independently or under supervision.

**Competence Level 4** : Ability to apply the subject without supervision and competence to advise others.

Guidance to candidates and mentors on possible ways in which the attributes may be satisfied is given below in brief. This is in terms of examples of ways in which candidates may choose to satisfy the attributes to the level of competence required but should be seen as guidance only.

### Attribute No. 1 : Finding Solutions & Concepts Creation (Require Competence Level 4)

**Objective:** Ability to produce viable structural solutions, within the scope of a design brief, taking account of structural safety & stability, economy, aesthetics, durability and sustainability.

The candidate should demonstrate competence in conceiving approximated scheme solutions to assess the viability of alternative structural forms, materials suitable for the same, and technologies for construction.

In producing concept designs, candidates should be able to demonstrate ability in understanding the following and more such relevant issues:

- a) Assessment of the design brief
- b) Location and use of the structure
- c) Function of Structural system
- d) Foundations and soil/structure interactions
- e) Load transfer mechanism and overall stability at all stages
- f) Progressive or disproportionate collapse
- g) Sustainability and environment
- h) Construction methods, constructability, materials and costs

### **Attribute No. 2 : Analysis & Design (Requires Competence Level 4)**

**Objective :** Ability to carry out analysis and design of structural forms and familiarity with relevant national and/or international design standards

The candidate should demonstrate an ability to solve structural engineering problems using the various suitable methods of analysis, including both traditional methods, using hand calculations, and computer analysis using proprietary software (after verifying efficacy of the software used). The candidate should also understand the limitations of various techniques.

Traditional methods of analysis should typically include multi-span continuous beams, slabs and plane frames or any other relevant structure. The candidate should demonstrate the ability to verify analysis by simple approximation and an understanding of the deflected structural forms.

The candidate should demonstrate theoretical knowledge and understanding of the performance of a structure as a whole, including plasticity and dynamics, besides an ability to appraise the design of structures for overall stability, resistance to progressive collapse, fire.

The candidate would typically be able to demonstrate competence in the following aspects of structural design:

- a) The design of at least one of the primary structural materials (concrete, steel, masonry, timber) and their interface. Use of different design philosophies such as Limit state method with their bases.
- b) The ability to carry out the design of individual components.
- c) The ability to determine and apply appropriate loading criteria and the ability to determine the appropriate load path.



- d) The ability to assess soil-structure interaction, including alternative sub-structure solutions appropriate to the form of construction and prevailing ground conditions.
- e) The integration of other design disciplines.

Training and experience of the candidate would typically include a balance of sub-structure, super-structure and foundation elements.

The candidate should have the ability to use the appropriate standards/Codes of Practice, specifications, publications by the Association, other technical publications such as bulletins, reports, commercial and relevant publications from other professional associations, etc., and apply the requirements or recommendations of these documents within specification or design criteria.

The candidate should have the ability to develop or review specifications, e.g. materials and workmanship specifications, project briefs, method statements.

Candidates should be able to perform the following tasks without supervision and be confident to advise others:

- a) Analysis of beams, trusses, braced and unbraced frame, and their interaction
- b) Buildability and construction techniques
- c) Movement joints
- d) The software packages involved in the analysis/design process
- e) Sub-frame analysis
- f) Structural planning
- g) Soil-structure interaction
- h) Various types of static and dynamic loading

### **Attribute No. 3 : Understanding the Materials Including Factors Affecting the Durability (Requires Competence Level 4)**

**Objective :** Understanding of various construction materials, their design models, ability to specify the appropriate materials and coordinate the use of materials.

The candidate should develop knowledge of the properties and behaviour of the primary construction materials, i.e. steel, concrete, masonry and timber, such that they can determine the advantages and disadvantages of the use of these materials and should have an understanding of the principles of material selection including durability.

Whilst they may choose to specialise in one or two materials – and thus have developed an ability in determining their behaviour – they should nonetheless have some knowledge of the availability, behaviour, cost, manufacture and principal engineering properties and potential applications of the main construction materials.

**Steel :** grades and types of steel and other metals including their physical properties like stress-strain curves, tensile strength, resistance to the buckling, fatigue, their limitations in use.



**Concrete:** grades and types of concrete – its use, durability aspects and properties including stress-strain curves, creep, shrinkage, thermal, resistance to fire etc.

Other materials including composites, masonry, timber, glass, plastics, etc. can also be considered.

#### **Attribute No. 4 : Experience in Construction (Requires Competence Level 3)**

**Objective :** Exposure to construction processes and related aspects to understand the complete cycle of realisation of the project from concept design to the finished product.

The candidate should demonstrate experience in construction techniques, construction plant and machinery, temporary support systems, material testing procedures, construction programmes, construction sequencing, etc.

Ideally, the candidate should complete a period of site experience on one or more construction projects, which is relevant to this attribute, i.e. it is mainly related to structural engineering elements.

It is recognised that not all candidates will be able to spend a continuous period on site for any significant length of time and in such cases they will be expected to accumulate experience to an equivalent of three months. A record should be kept by the candidate of all site-related matters, e.g. meetings, visits, inspections, surveys, testing procedures, supervision checking, etc., which will count towards their aggregate period of site experience.

It should be noted that the actual period of site experience is indicative only and the emphasis will be on the quality of experience rather than the quantity.

Candidates should be encouraged to gain knowledge and experience in some or all of the areas listed below:

- a) Demolition and site clearances
- b) Surveys & Setting out
- c) Materials testing
- d) Defects and their investigation
- e) Temporary works
- f) Substructure construction
- g) Superstructure construction
- h) Construction programming and sequencing, collaboration with other disciplines
- i) Site construction plant and equipment
- j) Health and safety
- k) Stability issues at various stages of construction



### **Attribute No. 5: Knowledge of New Developments (Requires Competence Level 2)**

**Objective:** Knowledge of new developments in the field of Structural, Civil and other branches of engineering.

Candidates should be encouraged to gain knowledge and experience in some or all of the areas of rapidly evolving technology listed below:

- a) Building Information Model (BIM),
- b) Structural Health Monitoring systems,
- c) new age materials,
- d) prefab, rapid modular constructions,
- e) 3D printing
- f) Recent developments in earthquake engineering

### **Attribute No. 6: Experience in Managing Design Projects Including its Commercial and Legal Aspects**

**Objective:** Experience in management skills for programming the activities and control and should have appreciation of the relevant law and statutory legislation, commercial and financial constraints, knowledge of quality systems

The candidate should demonstrate an appreciation of the law of the construction industry with respect to statutory legislation, health and safety legislation, insurance, contract laws, and the contractual obligations effective within the construction industry.

This experience may be gained through:

- a) Attendance at project meetings (design and contract)
- b) The development of project management skills including the definition and organisation of the project and its constituent phases
- c) The management of people and the interface with stakeholders within the project
- d) The development of time management and delegation skills
- e) Partnering

The candidate should demonstrate the following aspects of project management:

#### **Attribute No. 6.1: Experience in Management (Requires Competence Level 3)**

- a) Project team management and leadership skills.
- b) Programming and control of human resources, project resources, finances and administrative support.



- c) Liaison and interface management, interdisciplinary/inter-team liaison and exchanges of information with other disciplines.
- d) Overcoming the obstacles that come in the way of the team while fulfilling the objectives and targets of the project and organisation.
- e) Quality Management Systems e.g. BIS ISO 9001; or other relevant standards, Project Quality Plans, quality audits

Candidates are required to have experience of management and to have developed leadership skills through the programming and control of appropriate resources within a construction project and/or their design team.

Candidates should be aware of the needs and concerns of others, especially where related to diversity and equality, and develop an understanding of relevant legislation.

### **Attribute No. 6.2: Appreciation of Legal Aspects of the Project (Requires Competence Level 1)**

- a) Statutory legislation/negligence/liability laws
- b) Contract law
- c) Health and safety legislation
- d) Insurance matters
- e) Adjudication process
- f) Arbitration process
- g) The role of the expert witness

The candidate should demonstrate an appreciation of the law of the construction industry with respect to statutory legislation, health and safety legislation, insurance, contract law, and the contractual obligations effective within the construction industry.

### **Attribute No. 6.3: Appreciation of Commercial Issues Including (Requires Competence Level 1)**

- a) Costs and the impact of current affairs on the demand and supply of raw materials, labour and manufacturing processes
- b) Value engineering and whole life project costing
- c) Bill of quantities
- d) Competitive tendering
- e) Fee assessment and quotations
- f) Monitoring the control of project costs within their office

The candidate should be aware of commercial pressures within the construction industry and develop an appreciation of the effects of current affairs on the cost of raw materials, labour and manufacturing processes, market forces, the effects of taxation, etc.



The candidate should develop an appreciation of the methods of calculating construction costs, including documents used for estimating and measuring quantities and determining unit rates.

The candidate should appreciate the sensitivity of cost variations in construction techniques and appreciate the role of techniques such as value engineering and whole life project costing.

**Attribute No. 6.4: Knowledge of Different Forms of Contract Relative to the Candidate's Field of Work such as: (Requires Competence Level 2)**

- a) Public Private Partnership (PPP)
- b) Build, Operate, Transfer mode (BOT) and Hybrid Annuity Mode (HAM)
- c) Design and build contracts, EPC
- d) Management contracts
- e) FIDIC Contract document

The candidate should develop knowledge of the various standard forms of contract for the procurement of both construction and design services (e.g. QCBS) and a knowledge of appropriate procurement issues, e.g. partnering, dispute resolution, etc.

**Attribute No. 6.5 : Knowledge of Health and Safety Requirements and Related Legislation (Requires Competence Level 2)**

- a) Health and safety legislation
- b) Hazards and risk assessments
- c) Health and safety standards and reports of safety, e.g. SCOSS, CROSS and CROSFALL reports
- d) Insurance
- e) Risk management
- f) Security

The candidate should demonstrate knowledge of using health and safety standards and reports on structural and construction safety, publications produced by public authorities, relevant trade bodies and professional Associations.

The candidate should understand the role of hazard and risk assessments in avoiding or mitigating the potential risks posed by both construction materials and construction activities to site personnel, building users and the general public.

**Attribute No. 7: Communication (Requires Competence Level 4)**

**Objective:** Ability for effective communication, interpersonal skills and collaborating with others.

The candidates should demonstrate competence in effective communication ensuring that more than one possible meaning of his / her words or phrases are clarified and inter-personal skills using written, oral and visual media.



Where resources permit the candidate should demonstrate the ability to communicate via IT links, produce spreadsheets and database documents.

The candidate should develop ability in writing letters, summaries and reports, both factual and interpretative.

Where appropriate the candidate should develop drawing skills to be able to produce drawings to illustrate concept appraisals, feasibility studies and initial design details.

The candidate should have the ability to prepare and deliver presentations, project pre cis or design concepts, etc.

The candidate should have an appreciation of the skills of other professionals in the construction team and demonstrate an ability to work as an effective member of a diverse team.

Ability in communication and interpersonal skills will be assessed in the interview and via the documentation submitted by candidates. It is important that candidates have an understanding of the principles of effective communication and can highlight how they have developed the abilities as stated in the key attributes guidance note.

Candidates may choose to record involvement in the following:

- a) Formal communication e.g. technical report writing, drawings, sketches, correspondence with clients- letters, emails, minutes of meetings
- b) In-house & external presentations, sharing the ideas, publishing work in the journals/ magazines.
- c) Commenting, critiquing others work, giving feedback in writing.

### **Attribute No. 8: Commitment Towards Profession and Objectives of the Association (Requires Competence Level 2)**

Objective: knowledge of Standards of Profession of structural engineering, the responsibilities as a structural engineer towards society, environment & economics, and the objectives of the Indian Association of Structural Engineers.

Candidates are encouraged to support the objectives of the Association by involving themselves, for example, through the following :

- a) Industrial engagement with a local university/college in terms of delivering lectures, assisting in the marking of project work, mentoring the young engineers, etc.
- b) Regular attendance at Regional Group meetings/seminars.
- c) Regular contact with members of the Regional Group committee
- d) Regular reading of the Structural Engineer Digest, a quarterly journal of the Association and monthly newsletters
- e) Regular reading and participation in activities of CROSFALL





- f) Knowledge of the Association's services including CPD courses
- g) Knowledge of the international dimension of the Association
- h) Knowledge of and adherence to code of ethics of IAStructE.

This attribute could typically be met by attendance at three Association events per year or equivalent involvement in other professional Associations or relevant CPD (Continuing Professional Development) activities. The candidates may list their involvement with a brief overview of all activities and a brief commentary on at least three events.

The candidates should have awareness of other similar Associations or of other disciplines (e.g. IE(I), CEAI, fib, IABSE, IStructE-UK, ASCE etc.)