

*These columns of ICJ offer an opportunity to the engineering fraternity to express their views on the current practices in design, construction and management being followed in the industry.*

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# Guidelines for a structural engineer for practising as design consultant

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*The Committee of Profession and Practice of the Indian Society of Structural Engineers (ISSE) is currently working on a "Manual of Practice for the Structural Engineers". The committee is of the opinion that a separate chapter be added in the Manual dealing with the scope of work, methodology of services, responsibilities and liabilities of a practising structural engineer. The contents of the chapter are presented here with a view to solicit views from fellow engineers on this vital matter.*

A structural engineer may assume the role of a "structural design consultant", "project management consultant", "rehabilitation consultant" or "investigation consultant" depending upon his field of practice or scope of work for a project at hand. The present article concerns his role as a "design consultant".

A structural engineer is a person having requisite qualification and experience in the field of structural engineering and is duly registered with a competent statutory or local authority – and who undertakes the professional assignments of planning, design and supervision (through a few inspections) of only the structural part of the construction work. The duty of the structural engineer is to study his client's, requirements and to provide services as per the scope of work agreed between him and his client, with due regard to aspects of

economy, quality, time schedule, safety, maintenance and effects on environment.

Since the structural engineer is one among many agencies involved in a construction project, his scope and responsibilities cannot have a precise universally-accepted boundary. Interaction among several disciplines within structural engineering itself and also interaction with other branches of engineering, quasi-engineering and non-engineering disciplines is also very common.

## Scope of work and methodology of services

The comprehensive scope of work and the services of the structural engineer at various stages are discussed below. The records for these stages shall be created using standardised formats.

## Planning and structural design

The basic requirements of a good and efficient structural design are that it should be safe, durable, easy to construct, function-

ally and aesthetically good and reasonable in cost.

The structural engineer must acquire and record all necessary information prior to starting the actual design. In case of a subsequent information/addition/modification, the same should be recorded with the date on which the information was furnished and the stage or status of work on that date. The structural engineer may go through the following steps during this phase.

- Acquire and record the requirements of the project as a whole, prepare the "structural design data" sheet, get the same confirmed in writing and store it as a permanent record.
- Visit the construction site, if necessary, to get acquainted with the local conditions and surroundings.
- Advise/ initiate at the client's expense soil investigation, if considered necessary to decide upon the type of foundation to be adopted.
- Examine applicable codes and standards for fulfilling his scope of work.
- Prepare, if necessary, preliminary draft sketches and notes on structural work for the understanding of the requirements by the client/ architect.

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- Discuss the draft sketches, notes and outline with the client/architect and make modifications, if necessary, within the framework of the codes and good practice, to satisfy the requirements of the work.
- Prepare a sketch scheme and estimate the cost, with sufficient details for the purpose of tender and for proceeding to the stage of working drawing. Obtain written approval from clients/architects for the sketch scheme and the estimation of cost.

## Structural working drawings

Drawings are a means of communication for transforming the design concepts and specifications into actual work. Hence, the content, organisation and presentation of structural drawings should preferably be on the following lines.

- The set of structural drawings should consist of general arrangement (GA) drawings and other detailed drawings deriving reference from the GA drawings with key plans.
- The drawings should be prepared in a standardised manner and should have distinctly unique numbers for reference.
- As far as possible, the drawings should be drawn to scale.
- More intricate details should be depicted in bigger scales.
- The drawings should have adequate notes, sectional details, brief material specifications (concrete mixes, etc), legend, references to other relevant drawings and judicious use of hatching and shading.
- Wherever applicable, the drawings may contain bar bending schedules and bill of quantities.
- Whenever revisions are incorporated, the drawings should clearly indicate the revision number near the drawing number. The date and nature of revision should be listed in the table for revisions and changes/ alterations should be predominantly marked with the revision number.
- Whenever drawings are released for a certain purpose, the date of release and the purpose should be stamped on the prints.

It is advisable to list the limitations in respect of the responsibility and liability of the structural engineer on the GA drawings.

## Quality assurance

For quality assurance, the structural engineer may undertake the following:

- Initially formulate a control and reporting mechanism for the structural part and also specify the types of tests for materials and items (such as concrete cube tests) and stipulate their frequency. Insist on continuous superintendence of work and maintenance of proper records by the contractor. Check the reports periodically.
- Hold an educative workshop at the site to explain to the contractors and other agencies the salient features of the specifications and execution of work, watch points, the structural drawings, procedures of preparing memos, recording the progress of work, etc.
- Check and approve shop drawings, schemes and formwork submitted by contractors with respect to special watch points, for example, large span beams and camber, floors at heights, etc.
- Visit the site, as and when necessary, to inspect if the structural work is being executed in general accordance with his drawings and specifications. The important stages for inspection may be:
  - approval of foundation strata and founding level
  - typical footings, foundations, stub columns below ground level plinth beams, lift well and columns in ground/ stilts floor
  - checking of reinforcement for floor slabs/ systems and such important stages
  - inspection of large span/ heavily loaded beams, tall columns, cantilever staircases, etc.
  - checking of reinforcement of water tanks and lift machine room
  - typical members of structural steel structures such as stanchion, truss, gantry girder, etc.

Continuous supervision is not a part of the scope undertaken by the structural engineer and his inspection alone cannot guarantee that the work is carried out strictly in accordance with his drawings and specifications.

## Quantity control

Whenever quantity estimation or cost estimation is included in the scope of his work, a structural engineer should keep in mind the following.

- The bill of quantities and cost estimates of structural and other related items (such as excavation, plain concrete bedding under the footings, etc.) only shall be included in his scope.
- His commitment shall be for the quantities rather than their costs since cost can vary with time.
- His quantities will be for the structural design based on the original design parameters and if revisions and deviations are likely to influence the quantities significantly, the structural engineer should bring this fact to the notice of his client.
- Certain quantities are subject to marginal change during the execution due to their obvious uncertainty at the stage of design, for example, excavation, pile foundation, etc.
- Certain architectural requirements or other stipulations (such as elevational features, restricting beam widths to match the wall widths and beam depth to match the lintel level, disallowing columns at certain locations, etc) can have very significant influence on the structural quantities. The structural engineer should bring this fact to the notice of his client.
- The requirements of flexibility (for example, combining two neighbouring apartments, converting toilets, etc) or future extensions (for example, additional floors) can also have significant influence on the structural quantities. The structural engineer should bring this fact to the notice of his client.

## Certification

Depending upon the scope of work agreed between him and his client, the structural engineer should issue various documents and certificates. More specifically, he should do the following:

- Prepare inspection report at the completion of every stage of the construction work after receiving a certificate of satisfactory completion from the contractor and the site supervisor or the project management consultants as the case may be (such stages should be defined in advance).

- At the end of completion of the entire civil works, the contractor and the site supervisor shall give a certificate of completion to the structural engineer who, relying on their certificate and also on his own inspection reports, shall issue the certificate of "structural stability". The structural engineer may refuse to issue in writing the same giving reasons thereof provided that such refusal by the structural engineer shall also contain the description of the short-comings or deficiencies and reasons of their occurrence during the construction. He may also suggest remedial measure, if any.
- If the structural engineer has refused the certificate of structural stability citing deficiencies and also giving remedial measures, he shall issue the certificate of structural stability on receiving the compliance of the remedial measures from the contractor and the site supervisor in writing and after further inspection, if necessary.

### Post completion submission

On completion of the work, the structural engineer should hand over the following documents to his client:

- Design parameters
- Two sets of as-built (final) structural drawings
- A list of precautionary measures to be taken during renovation or interior decoration, etc, some of which may be as below.
  - The mode of use shall not be changed unless ascertained by a structural engineer.
  - Walls should not be removed or shifted without the consent of a structural engineer.
  - Toilet position should not be changed.
  - No structural member such as a column, beam or slab shall be tampered with or removed without consulting a structural engineer.
  - Fans shall not be suspended by hooking to the slab reinforcement; anchor fasteners shall be used for the purpose.
  - Holes shall not be made in structural members by using hammer without consulting a structural engineer and if allowed, drill machine shall be used for drilling holes.

- Deep soil filling or flowerpots filled with soil shall not be stacked on canopy and chajjas.
- Terrace garden, swimming pool, etc, shall not be provided unless originally designed for.
- Plinth beam shall not be tampered with while lowering plinth. Lowering of plinth if permitted shall not be undertaken without a structural engineer's approval and supervision.
- No loft or mezzanine shall be constructed unless originally planned for.
- Any special instructions regarding preventive maintenance of the structural work and a list of load bearing items in a predominantly reinforced concrete framed structure.

### Responsibilities and liabilities

The responsibility of the structural engineer shall be commensurate with the scope of work agreed between him and his client. The structural engineer shall be liable if he fails to exercise all reasonable skill, care and diligence in the discharge of his duties under these conditions; but the aforesaid liability shall be limited as stated below.

- The liability of the structural engineer shall expire at two years from the date of issue of the stability certificate.
- During execution, his commitment shall be for the structural quantities rather than their costs since costs can vary with time.
- His liability will be for the design parameters submitted along with the certificate of structural stability. The liability shall expire in the event of changes in the parameters thereafter.
- The structural engineer shall not be responsible for not following codes of practice and stipulations, which were not mandatory during the stage of structural design. He will also have no liability towards the safety or stability of the structure for the stipulations which may be mandatory now but which were not in existence when the structure was designed.
- Unless explicitly laid down in his scope of work, the structural engineer shall not be responsible for the safety or stability of the scaffolding/ staging and

any other temporary structures.

- He shall not guarantee the work of any contractor.
- The structural engineer shall have no liability whatsoever for any part of the works not designed or supervised by him or not under his responsibility or which has been constructed without or contrary to his specifications.
- He shall have no liability whatsoever for any damage to life and property whatsoever resulting from any act of client, contractors, suppliers or other agencies during the execution of work.
- The structural engineer shall have no liability whatsoever for any violation of legal provisions of rights of third parties, governments, etc, unless these provisions or rights have been specifically brought to the notice of the structural engineer well in advance by the client in writing.
- He shall not be liable for any damage resulting out of bad maintenance, overloading, additions and alternations, structural changes and the like by the client or the occupier.
- The structural engineer shall maintain all important records in his office for a period of 7 years from the date of certificate of stability and shall furnish copies of the records on receiving a formal request from the occupier by charging costs thereof.
- All the copyrights of designs shall vest with the structural engineer and the structural drawings and specifications shall be the property of the structural engineer.

### References

1. \_\_\_\_\_ *Report of the Committee of Municipal affairs (Khan Committee) appointed for studying the recommendations of various committees appointed for investigating into the causes of collapses of buildings*, Mumbai 1998.
2. \_\_\_\_\_ *Manual of Practice by PEATA (Practicing Engineers, Architects and Town Planners' Association)*, Mumbai.
3. \_\_\_\_\_ *Construction Administration: Pitfalls We Can Avoid*, Structural Engineers Association of Colorado, USA, October 1998.
4. \_\_\_\_\_ *Proposed guidelines for authorities and responsibilities in concrete design and construction from the responsibility in concrete construction committee*, *Concrete International*, March 1994, pp. 60-63.

