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Draft Indian Standard

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सरचनात्मक डिजाइन और संरचनाओं की प्रमाण जाँच के लिए परामर्श सेवाएँ की अपेक्षाएँ

REQUIREMENTS FOR STRUCTURAL DESIGN AND PROOF CHECKING CONSULTANCY SERVICES FOR STRUCTURES

ICS 91.010.01, 91.010.20

Construction & Related Engineering Services Sectional Committee, SSD 06

FOREWORD

(formal clause to be added later)

The need for proof checking of structural designs has been recognized as an essential step for reinforcing the need for public safety in tandem with the rapid advancement on engineering and the fast pace of development that is happening in the country. Adding confidence and reducing risk through such a procedure is essential since it provides for risk mitigation on account of errors in the design stage and thus ensures better safety.

The intent of this standard is:

- (a) To overcome the shortcomings of the current practices and terminologies being followed (in the Public and Private sectors), and suggest those that ought to be adopted and followed as a matter of good sustainable practices.
- (b) To eliminate subjectivity and bring openness and uniformity in the qualification requirements and appointment of a Structural Design Consultant and a Proof Consultant.
- (c) To remove ambiguities evident or implied, by defining and thus clarifying the various associated terms.

The standard defines role and responsibilities of various stakeholders, different models of appointment of Principal Design Consultant and different categories of proof checking based on their level of independence. It also includes the educational qualification of team leaders of both PDC as well as PC.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2: 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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REQUIREMENTS FOR STRUCTURAL DESIGN AND PROOF CHECKING CONSULTANCY SERVICES FOR STRUCTURES

1 SCOPE

The standard covers structural design and proof checking consultancy services of all types of civil engineering structures such as masonry, reinforced concrete, timber, steel, composite, etc. It also includes responsibilities, educational qualifications and deliverables expected from all the stakeholders.

2 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

2.1 Build and Deliver Mode (Traditional Mode) — The delivery mode in which the owner is responsible for providing the preliminary design and drawings, technical specifications, Bill of Quantities (BOQ), and detailed designs and drawings to the constructor for the execution of the works.

NOTE — The constructor is responsible to build and deliver.

2.2 Comprehensive Design Consultant (CDC) — An individual or organization responsible for comprehensive multidisciplinary engineering consultancy services including structural design services.

2.3 Constructor — The individual or organization appointed by the owner and is responsible for the execution of the construction works as per approved drawings and specifications.

2.4 Design, Build and Deliver Mode — The delivery mode in which the owner provides the detailed scope, performance specifications and design basis report at the time of bidding to the constructor.

NOTE — The design and execution shall be responsibility of constructor.

2.5 Owner — The individual or organization that owns the project and engages the constructor, Principal Design Consultant (PDC) and Proof Consultant (PC), as required.

2.6 Principal Design Consultant (PDC) — The individual or organization responsible for structural analysis and design of the structures.

2.7 Proof Checking — Review of structural designs by an individual or organization that is not a part of the original design team.

2.8 Proof Checking Consultant (PC) — The individual or organization responsible for proof checking.

2.9 Structural Design — Implies all the stages related to a structure that includes conceptualization, planning, analyses, designs, drawings, detailing, constructability, durability, sustainability and maintainability to ensure that the structure performs the functions specified over its intended design life as per applicable standards.

NOTE — Structural design includes ensuring the completeness and correctness of parameters incorporated in the structural analysis, loading and load combinations, structural analysis and design of the structure to ensure compliance with the structural design requirements of the construction contract, relevant safety standards, codes and best engineering practices as well as model studies where required and duly incorporating the requirements of the technology know-how suppliers, system and equipment vendors, specialist consultants, as engaged by

owner/constructor/CDC.

2.10 Team Leader — The person responsible for overseeing and coordinating the work of the team engaged in the structural analysis and design or its proof checking, and having authority to sign on behalf of the team.

3 REQUIREMENTS FOR SERVICES

When determining the requirements for the structural design and proof checking consultancy services offered to the owner/constructor/CDC, the PDC and PC shall ensure that the requirements for the services are complied, which shall include the following:

- a) All applicable statutory and regulatory requirements;
- b) Functional requirements of the structure, (inter alia of technology know-how suppliers, system & equipment vendors, specialist consultants, et al.);
- c) Consideration of the relevant construction stage loadings;
- d) Design life of the structure;
- e) Consideration of risks including multi-hazard risks; and
- f) Any specific requirement of the owner.

4 APPOINTMENT OF PDC

4.1 The owner/constructor/CDC (depending on project delivery mode) shall appoint the PDC for the structural design of the structures.

4.2 In case of contracts where the structural design is in the scope of the constructor/CDC, the constructor/CDC shall be responsible for providing sound and safe structural design. The design team of the constructor/CDC shall have minimum qualification and the experience of PDC as specified in **9.2**.

4.3 In case the PDC is appointed by the constructor/CDC externally, the agreement between owner and constructor/CDC should clearly stipulate the conditions for appointment of PDC in terms of role, responsibility, experience, fee payable etc. Constructor/CDC, whoever appoints the PDC, shall be primarily responsible and accountable for providing sound and safe structural design. The PDC appointed shall have minimum qualification and experience as specified in **9.2**.

5 APPOINTMENT OF PC

5.1 The owner may appoint a PC for proof checking of the structural design of the structures prepared by PDC.

5.2 The PC shall in all cases be always appointed by the owner so that the PC is never subservient to the Constructor/ CDC.

5.3 In case the owner has an in-house design team and the technical competency available as specified in **9.2**, the owner may either take up the responsibility of PDC or PC. The owner shall never be both PDC as well as the PC simultaneously.

5.4 The constructor/CDC shall never act as proof checking consultant.

6 MODEL OF APPOINTMENT OF PDC AND PC

The contractual model for appointment of the PDC and the PC may vary according to the nature of the project and the contract delivery mode.

6.1 Model 1— Owner Appointed PDC and PC

The owner shall directly appoint both the PDC and the PC for structural designing and for proof checking, respectively. The Good for Construction (GFC) drawings shall be issued by the PDC to the owner after approval by the PC as shown in Fig.1.

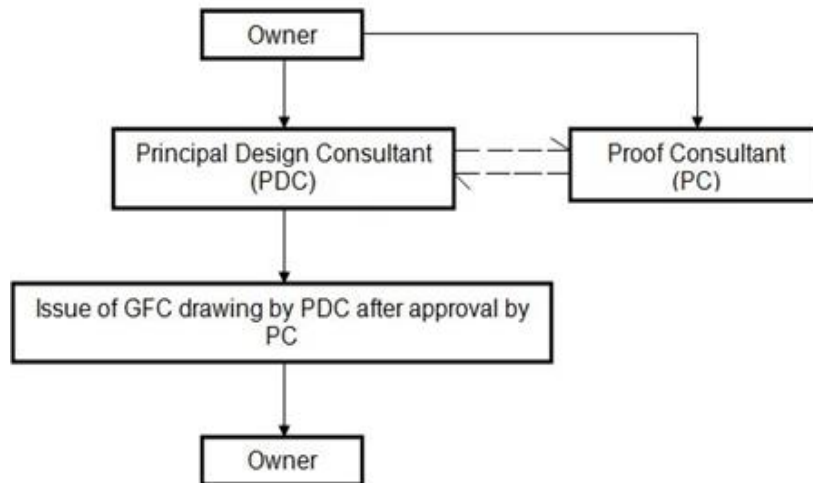


FIG. 1 MODEL 1— OWNER APPOINTED PDC AND PC

6.2 Model 2 — Constructor Appointed PDC

A design and build constructor as well as a PC shall be independently appointed by the owner. The PDC shall then be appointed by the constructor. The Good for Construction (GFC) drawings shall be issued by the PDC to the constructor after approval by the PC. The Constructor shall submit design and GFC drawings to the owner for his in-principle approval before execution of the work as shown in Fig.2.

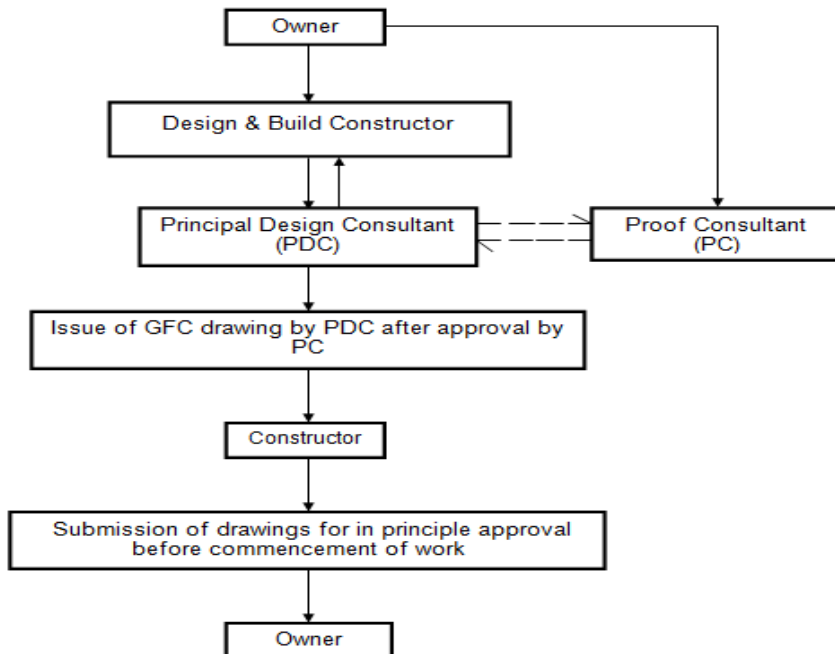


FIG. 2 MODEL 2 — CONSTRUCTOR APPOINTED PDC

6.3 All communications between the PDC and the PC shall be routed through the owner.

7 SCOPE AND RESPONSIBILITIES

7.1 Owner

The owner shall hold responsibility for the project either directly or through its authorized representative or implementing agency. The owner shall also:

- a) Prepare the contractual stipulations for the PDC and PC and ensure that they have the desired qualification and required experience to carry out their respective assignments as specified in **9.2**;
- b) Provide site specific data and design requirements like the design brief, the conceptual drawings, surveyed site plan, geotechnical investigation report, proposed materials and methods of construction, the relevant contractual conditions, the functional requirements and constraints if any and any special construction loadings;

NOTES

- 1 The design brief should articulate all the functional needs and aspirations as well as any other special need of the owner. It should also address the issues related to the site and situation which the owner wants the PDC to incorporate in the structural designs.
 - 2 The above inputs may be required to be provided by the constructor to the PDC under design, build and deliver mode of the contract.
- c) Appoint the technology know-how suppliers, system and equipment vendors, all specialist consultants as per project specific requirement;
 - d) Ensure that the scope of work for PDC and PC, including deliverables from them shall be well defined and a workable time schedule given for structural design and proof checking;
 - e) Recognize that there can be differences of opinions between PDC and the PC on the structural design issues and that need to be resolved by the owner in consultation with the PDC and PC. In case of an unresolved difference in opinion, an independent third-party view may be obtained by the owner. The third party shall also meet the qualification and experience criteria as specified in **9.2** for the team leader of PC. The decision of the owner shall be final;
 - f) Ensure that adequate supervision and quality control is provided by themselves or by appointing a suitable agency during various stages of construction and that the construction materials and methods are as specified in the contract drawings and specifications;
 - g) Ensure that the structure is used as intended and maintained adequately on a regular basis;
 - h) Ensure to include the intention to appoint PC, if applicable, as a condition of contract with the PDC, Constructor and Specialist Consultants;
 - j) Ensure that the responsibilities of PDC/ PC are clearly specified in the conditions of contract to be made with them. The contract conditions between the stakeholders may have provisions regarding professional liability insurance; and
 - k) Avoid revisions and corrections in design inputs and architectural and service drawings, which may impact the structural design, subsequent to submission of structural design by PDC in case of Build and Deliver Mode. Revision/corrections in architectural and service drawings and other design inputs should be done only in exceptional and unavoidable circumstances.

7.2 Principal Design Consultant (PDC)

- a) The PDC shall be responsible for the completeness and correctness of the structural designs and also for the incorporation of requirements of the technology know-how suppliers, system & equipment vendors, various specialist consultants appointed for the project and for the optimization of the structural designs;
- b) PDC shall ensure the availability and completeness of the information/ reports from the owner/constructor/CDC and ensure that they are incorporated into the designs:
 - 1) The design brief, the functional requirements and constraints if any, from the owner;
 - 2) Site contour and boundary lines survey;

- 3) Geo-technical investigations and recommendations;
 - 4) Conceptual, detailed architectural and service drawings of the proposed structure;
 - 5) Drawings for the proposed structures;
 - 6) Proposed materials and methods of construction;
 - 7) Relevant construction stage loadings;
 - 8) Incorporation of notes/ drawings regarding temporary safety requirements during construction;
 - 9) The relevant contractual conditions; and
 - 10) Any other data relevant to the project and required for structural design;
- c) The PDC shall be responsible for submission of comprehensive design documents and drawings to the owner for proof checking. The design calculations shall be presented in a manner which is easily comprehensible and can be checked. Every document shall be page numbered. Design calculations shall be presented with adequate cross referencing to codes, standards, Design Basis Report (DBR) and other documents, wherever necessary. The design notes shall contain explanatory sketches of the structure and loadings. All documents and drawings shall be physically and/or digitally signed with date and stamped by the team leader of the PDC;
- d) The PDC shall ensure compliance of the observations raised by the PC. Differences of opinion between the PDC and the PC shall be resolved by the owner as specified in **7.1(e)**;
- e) The involvement of PC shall not relieve the PDC of the responsibility towards correctness, adequacy and completeness of the structural designs;
- f) PDC must act independently of the PC, constructor and any of their sub-constructors or consultants, and shall maintain confidentiality throughout;
- g) Conflict of interest, if any, shall be declared by the PDC prior to accepting the assignment for structural design; and
- h) The PDC shall have an explicit agreement with the owner/constructor about the scope of work.

7.3 Proof Consultant (PC)

- a) The PC shall be responsible for reviewing the completeness and correctness of the structural designs;
- b) The PC shall not be part of the main design team;
- c) The PC may be consulted by the PDC during the design process to provide preliminary thoughts, opinions, or comments on critical issues;
- d) PC must act independently of the PDC, constructor and any of their sub-constructors or consultants, and shall maintain confidentiality throughout;
- e) Conflict of interest, if any, shall be declared by the PC prior to accepting the assignment for proof checking except where the PC and the owner are the same;
- f) The PC shall have an explicit agreement with the owner about the scope of work;
- g) The PC shall review the design documents and drawings produced by the PDC;
- h) Technical interaction between the PDC and the PC shall be well documented;
- j) The scope of a PC shall be to thoroughly check the analysis and design calculation documents and the structural drawings;
- k) The PC shall ensure that the structural system/ scheme chosen by the PDC meets the parameters as stated in **7.2 (b)**;

- m) The PC shall share equal responsibility with PDC for the accuracy and completeness of all the analyses, designs and drawings of the structure; and
- n) If necessary, the PC may do independent calculations to form a basis for arriving at the conclusions. Independent calculations shall invariably be done for all large or complex or important structures.

NOTE—All documents and drawings shall be physically and/or digitally signed with date and stamped by team leader of PC before submitting them to the owner.

7.4 Constructor

The Constructor shall ensure that:

- a) Proper document control is followed at the site. The latest GFC drawings shall always be available at the site and same shall be used for construction;
- b) In case of Design, Build and Deliver mode, the PDC shall have the minimum educational qualification and the requisite experience as specified in 9.2;
- c) All the contract conditions and specifications shall be followed and the project shall be delivered as per the latest GFC drawings;
- d) The construction material, the workmanship and the finish meet the requirements of the specifications as given in the contract and/ or as per the relevant codes and standards in case they are not specifically incorporated in the contract, whichever is more stringent;
- e) All the fabrication drawings and the methodology of construction to be adopted by the constructor are as agreed under the contract;
- f) There is proper supervision and quality control for each and every activity at the works by deputing qualified and experienced engineers and trained workers (skilled as well as unskilled) during all the stages of construction; and
- g) In case of contracts where PDC is appointed by constructor, the constructor should Avoid revisions and corrections in design inputs and architectural and services drawings, which may impact the structural design, subsequent to submission of structural design by PDC in case of Design, Build and Deliver mode. Revision/corrections in architectural and service drawings and other design inputs should be done only in exceptional and unavoidable circumstances.

8 CATEGORIES OF PROOF CHECKING

Proof checking shall be classified in two categories considering the levels of independence in proof checking and the degree of liability of the PC:

8.1 Category 1

- a) The PDC shall prepare the Design Basis Report (DBR) and framing plans and discuss them with the PC, who shall review and then approve the same;
- b) PDC shall also discuss with the PC the method and mode of analyses and designs – manual or computerized, including use of any specific computer programmes, idealization of the structure and its various elements, and the PC shall need to approve the same;

- c) Structures for which model studies (physical or digital) have to be performed - the same shall also be discussed by the PDC with the PC. The studies to be carried out shall be decided as well as the agency which shall be appointed by the owner to carry out the model studies. The report of the model study shall be submitted to the owner who shall forward the results/ reports of the model studies for review and discussion by the PDC and the PC with the agency appointed for the same. The PDC and PC shall convey their acceptances of the model study report separately in writing to the owner;
- d) PDC shall carry out the analyses and designs, as discussed with and approved by the PC, and thereafter prepare the structural drawings, and submit the entire package to the PC for the latter's scrutiny and approval;
- e) This interaction between PDC and PC can be carried out periodically at different stages of the project to suit the construction requirements;
- f) PC shall communicate approval for the analyses and later on for the designs in writing; and
- g) PC shall sign the structural GFC drawings, which are already signed by PDC. The signed drawings shall then be submitted to the owner.

8.2 Category 2

- a) The PC and PDC shall discuss and finalize a mutually agreed DBR including conceptual structural system and schematic drawings;
- b) PDC shall have the freedom to analyze, design and detail the structure, and submit only the structural drawings to the PC;
- c) The PC shall carry out independent analysis and designs, PC shall review and approve the structural drawings, in part, or of the complete structure and sign the GFC drawings; and
- d) PC shall communicate approval in writing and sign the structural GFC drawings after they are signed by the PDC. The signed drawings shall then be submitted to the owner.

NOTE — In Category 2, if there is a difference in the final results of the analyses between those done by the PDC and the PC, then both shall discuss the same based on the available accepted literature and references, to resolve the matter and finalize the analysis and designs so that the drawings based on the agreed approach could be issued. In case, if any difference of opinion still remains between the PDC and the PC, then the owner shall resolve them as specified in 7.1 (e)

9 SUPPORT

9.1 General

The PDC and PC shall have adequate resources which shall inter alia include competent manpower i.e. qualified and experienced structural design engineers, draftsman and other associated manpower, infrastructure, equipment, environment for operation of all the processes and other facilities required to perform and complete the work effectively, accurately and within the timeframe mutually agreed to with the owner.

NOTE — Infrastructure should inter alia include the following:

- 1 Buildings and associated utilities,
- 2 Requisite computer hardware and software,
- 3 Transportation resources,
- 4 Information and Communication technology, with over 99 percent uptime, and
- 5 Adequate automatic backup power supply where that is necessary.

9.2 Minimum Qualification and Experience of PDC and PC

9.2.1 The owner/ constructor/CDC shall make sure that the PDC and the PC, as applicable, engaged for the project have the requisite minimum educational qualification and relevant experience for the structural analyses, designing and drawing for the project concerned as given in Table 1.

NOTE — The owner may decide the additional qualification for PDC or PC based on the type of structure, health, safety and disaster (like earthquake, cyclone, etc.) vulnerability requirements.

9.2.2 The team leader of both the PDC as well as the PC shall be an engineer who is engaged in the practice of structural engineering and shall have experience with the design of structural systems comparable in type, size and complexity with those under consideration.

9.2.3 All members of the PDC or PC team engaged in structural analysis and design shall possess minimum educational qualification of BE/ B Tech (Civil).

Table 1 Minimum Qualification and Experience of Team Leader of PDC and PC
(Clause 9.2.1)

Type of Structure (1)	Team leader of PDC (2)	Team leader of PC (3)
Buildings up to the height of 15 m	BE/B Tech (Civil) with 5 years of experience in structural engineering practice with designing and field work.	BE/B Tech (Civil) with 7 years of experience in structural engineering practice with designing and field work.
High rise buildings of height more than 15 m and less than 50 m	BE/B Tech (Civil) with 7 years of experience in structural engineering practice with designing and field work.	BE/B Tech (Civil) with 10 years of experience in structural engineering practice with designing and field work.
Tall buildings more than 50 m and specialized structures such as but not limited to tunnels, bridges, flyovers, elevated roads, dams, chimneys, industrial, marine, and special structures.	BE/B Tech (Civil) with 10 years of experience in structural engineering practice with designing and field work of relevant structures	Master's degree with major in structural engineering and 10 years of experience in structural engineering practice with designing and field work of relevant structures, or BE/ B Tech (Civil) with 15 years of experience in structural engineering practice with designing and field work of relevant structures

NOTES

1 In case of Master's degree in structural engineering, the required minimum experience may be reduced by 1 year and in case of a doctoral degree it may be reduced by 2 years.

2 The team leader of PDC and PC can be academic faculty of recognized engineering institutions with relevant design experience as given above.

10 OWNER SATISFACTION

PDC/PC shall obtain a letter of satisfaction from the owner in relation to the requirements given by the owner in the design brief with reference to the agreed functional requirements and deliverables.