

# CONSTRUCTION TECHNOLOGY & MANAGEMENT (CE308)

Semester VI  
B. Tech  
Civil Engineering

IIT Guwahati



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**Dr. Santu Kar**

# PREFACE

This project serves as an introductory gateway into the realm of construction technology and management, a domain where creativity meets functionality, and where meticulous planning intertwines with practical execution. The landscape of construction technology and management is ever evolving, driven by advancements in materials, techniques, and methodologies.

Within these pages, readers will embark on a voyage through the various facets of construction, delving into topics such as project planning, scheduling, cost estimation, budgeting, and construction methods.

Moreover, this preface recognizes the pivotal role played by practitioners, educators, researchers, and industry professionals in advancing the frontiers of construction technology and management. Their expertise, insights, and contributions are invaluable in driving innovation, fostering excellence, and nurturing the next generation of talent in this field.



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## PROJECT INFORMATION

Salient details of the work for which bids are invited areas under:

<b>Sl. No.</b>	<b>Name of Work</b>	<b>Estimated Cost</b>	<b>Period of Completion</b>
1	Construction of 160 units in (G+9) F-Type Residential Towers at IIT Guwahati Campus	Rs.126,60,51,279/- (as per CPWD & Market Rates)	30 Months (including rainy season)

2. The work is to be done at Indian Institute of Technology– Guwahati located at AminGaon, Guwahati, Assam.

### 3. General Features

Scope of work involves Construction of 4 blocks of 40 units each G+9 storied F-type quarters, including.

- a. Pile Foundation
- b. Water supply & sanitary works
- c. Internal Electrification works
- d. Fire detection & alarm system and Fire fighting works
- e. Site development works including road, pavement, drains, etc
- f. Lift works

4. Work shall be executed in accordance with General Condition of Contract read along with the Special Conditions of Contract, if any, and the Particular Specifications, Drawings etc. forming part of this bid document.

# **Minimum Eligibility Criteria for submission of bid documents**

The Bidders, who fulfill the following minimum requirements, shall be eligible to apply, subject to the following:

- Joint Ventures are not accepted; neither works executed by the bidder for/through another contractor on back-to-back/sub-contracting basis shall be considered.
- Prospective bidder(s) should not be blacklisted/banned/debarred/restrained from working/participation in tendering in any organization in last seven years from the date of issue of this Notice Inviting Tenders.
- The Bidders should have satisfactorily completed following works during the last Seven years ending previous day of last date of submission of tenders:
- Three similar works each costing not less than Rs. 5,064.21 Lakh, or two similar works each costing not less than Rs. 6,330.26 Lakh, or one similar work costing not less than Rs. 10,128.42 Lakh. Similar work shall mean Construction of RCC framed Residential, Office, Hostel, Institutional or such other buildings. Bidder's performance for each of the qualifying work completed in the last Seven years should be certified by an officer not below the rank of Executive Engineer/Project Manager or equivalent.
- The Bidder should have satisfactorily carried out Pile foundations of cumulative length not less than 27000mm of minimum 400mm dia piles in a single contract.

- Bidder must have executed at least one single RCC framed structure/building of minimum 6 stories including basement/stilt/ground floor.
- Bidder shall submit TDS Certificates in Form 26AS or Form 16A, as support of execution of the qualifying works failing which the technical bid is liable to be rejected, without any further reference to the bidder.
- The bidder should have had average annual financial turnover (gross) of Rs. 3,798.16 Lakh from Construction works during the last available three consecutive financial years ending 31st March 2017, i.e., 2014-15, 2015-16 & 2016-17. Audited balance sheet & profit & loss statement shall be submitted for the same.
- The bidder should not have incurred any loss in more than two years during available last five consecutive balance sheets, i.e., 2012-13, 2013-14, 2014-15, 2015-16 & 2016-17 as per the Auditor's report.
- Bidder should have adequate residual bidding capacity (equal to or more than Rs. 12,660.52 Lakh), which shall be exhibited by the bidder with detailed calculation.
- The bidder should produce a solvency certificate of minimum Rs. 5,064.21 Lakh from any Nationalized/Scheduled bank, not more than six months old.

## **List of Documents to be provided by the Bidder**

1. Demand Draft of any Nationalized/Scheduled Bank against Tender Fee
2. Demand Draft/Payorder/Banker's Cheque/Fixed Deposit Receipt/or Bank Guarantee of any Nationalized/Scheduled Bank against EMD
3. Partnership Deed, Memorandum of Association of Company as the case may be
4. Power of Attorney of the bid signatory as applicable
5. Letter of Transmittal
6. Certificate of Financial Turnover from Chartered Accountant (Form 'A') including audited Balance sheets and Profit & Loss Statements
7. Bank Solvency Certificate (Form 'B')
8. Certificates of Works Experience (Form 'C', 'D' & 'E') including Work Orders, Completion Certificate etc. as applicable
9. Organization Structure (Form F)
10. Details of Technical & Administrative Personnel (Form 'G') including their CV/Biodata & Certificates
11. Details of Construction Equipment (Form 'H') including their proof of purchase/registration in Bidder's name
12. Affidavit for "No back to back execution of work" (Form 'I')
13. PAN Card issued by Income Tax Department
14. Certificates of registration for GST
15. Registration with EPFO and ESIC
16. Enlistment order of the contractor in any Government/PSU or other Government Organization



17. Complete Bid document including IFB, NIT, IIFB, Standard Form of Contract (GCC & SCC) including Appendices (all pages duly sealed & signed by the bidder)
18. Scope of Work, Particular Specifications & Drawings (if any) and the Pre-priced Schedule of Quantities & Rates forming part of Schedule-A (all pages duly sealed & signed by the bidder)
19. Price Bid, i.e., BOQ (Schedule-A), as applicable in case of online PDF format bid submission
20. All other document(s) as specified in the Bidding Document(s)

# **TYPE OF CONTRACT**

This contract is a lumpsum contract.

- A lump sum contract in construction management is a type of contract where the contractor agrees to complete a project for a fixed price. Under this arrangement, the total cost of the project is determined upfront and is not subject to adjustment unless the scope of work changes. Lump sum contracts provide clients with a clear understanding of project costs and give contractors the incentive to complete the work within budget and on schedule. However, contractors may include contingencies in the lump sum price to account for potential risks or uncertainties. This type of contract is commonly used for projects with well-defined scopes of work and where the client wants to avoid the risk of cost overruns.

Lump sum contracts offer several advantages for both clients and contractors in construction projects:

- **Cost Certainty:** With a lump sum contract, the client knows the total cost of the project upfront, providing financial predictability and helping with budgeting and financing arrangements.
- **Reduced Risk for Clients:** Clients are protected from cost overruns and unexpected expenses since the contractor bears the risk of completing the project within the agreed-upon budget.
- **Simplified Budgeting:** Lump sum contracts simplify financial planning for clients since they don't have to anticipate additional costs beyond the agreed-upon price.
- **Incentive for Efficiency:** Contractors have an incentive to complete the project efficiently and within budget to maximize

their profits, which can lead to improved project management and cost control.

- **Clear Scope of Work:** Lump sum contracts typically have well-defined scopes of work, reducing the potential for disputes over project specifications and requirements.
- **Streamlined Administration:** Since the price is fixed, there's less need for ongoing cost monitoring and administration compared to other contract types, saving time and resources for both parties.
- **Enhanced Collaboration:** Lump sum contracts often encourage collaboration between the client and contractor during the project planning phase to ensure a clear understanding of project requirements, timelines, and deliverables.

Overall, lump sum contracts provide a structured framework for construction projects, promoting transparency, efficiency, and accountability for both clients and contractors.

## **GENERAL RULES AND DIRECTIONS**

- ❖ All work to be contracted will be announced through public notices or publications, specifying details such as the nature of the work, tender submission and opening dates, time allowed for completion, and required deposits.
- ❖ Tender documents, including specifications, designs, and drawings, will be available for inspection by contractors during office hours.
- ❖ The tendering process will include the submission of earnest money, security deposits, and performance guarantees by successful tenderers.
- ❖ Contractors must inspect the tender documents and comply with the requirements outlined in the invitation to tender.
- ❖ The officer inviting tenders will oversee the process and ensure transparency and compliance with regulations.
- ❖ If the tender is submitted by a firm, it must be signed separately by each partner.
- ❖ In the absence of any partner, the tender must be signed on his behalf by a person holding a power of attorney authorizing them to do so.
- ❖ The power of attorney must be produced with the tender and must indicate that the firm is duly registered under the Indian Partnership Act, 1932.
- ❖ When payments are made on account of work executed by a firm:
- ❖ Receipts must be signed by all the partners, except when the contractors are described in their tender as a firm.
- ❖ In such cases, the receipts must be signed in the name of the firm by one of the partners or by another person authorized to give receipts on behalf of the firm.

# **CONDITIONS OF CONTRACT**

- ❖ **Definition of Contract:** It encompasses various documents including tender, formal agreement, specifications, designs, drawings, and instructions issued by the Engineer-in-charge.
- ❖ **Key Definitions:** Works, Site, Contractor, President, Governor, Managing Director, Engineer-in-Charge, UPRNN Ltd, Accepting Authority, Expected Risks, Market Rate, etc.
- ❖ **Contractual Terms:** It defines various terms related to payments, approvals, directions, constructional plant, materials, drawings, specifications, and more.
- ❖ **Scope and Performance:** It outlines the scope of work, including labor, materials, tools, and equipment required for execution and completion.
- ❖ **Sufficiency of Tender:** Contractor must ensure correctness and sufficiency of tender and rates quoted. Discrepancies and Adjustment of Errors: Procedures for handling discrepancies between documents and resolution of errors.
- ❖ **Signing the Contract:** The successful tenderer must sign the contract within 30 days of acceptance, which includes various standard clauses and safety regulations. Overall, it provides a comprehensive framework for the construction project, defining roles, responsibilities, and procedures to be followed throughout the contract duration

## **CLAUSES OF CONTRACT**

- **CLAUSE 1** Performance Guarantee: The contractor must provide a performance guarantee of 5% of the tendered amount, which can be extended based on the Engineer-in-Charge's discretion. Failure to extend the guarantee or pay dues to UPRNN Ltd can result in forfeiture. An additional performance guarantee is required for unbalanced bids.
- **CLAUSE 2** Security Deposit: UPRNN Ltd can deduct 5% of the gross amount of each bill as a security deposit until it reaches 5% of the tendered value. This can be done through fixed deposit receipts. In case of non-payment, the contractor must provide additional security.
- **CLAUSE 3** Compensation for Delays: If the contractor fails to maintain progress or complete the work on time, compensation is payable at a rate of 1% per month of delay, capped at 10% of the tendered value. There's also a provision for early completion bonuses.
- **CLAUSE 4** Contract Termination: The contract can be terminated by UPRNN Ltd for various reasons outlined, with forfeiture of certain guarantees and the ability to recover expenses or damages.
- **CLAUSE 5** Extensions of Time: Extensions of time may be granted for delays caused by specified events or reasons beyond the contractor's control, subject to approval by the Engineer-in-Charge.
- **CLAUSE 6** outlines the procedures for measurement and valuation of work done under the contract. It requires the Engineer-in-Charge to determine the value of work done through measurement according to the contract specifications. All measurements are to be recorded in a Measurement Book and/or level field books jointly by the

Engineer-in-Charge (or representative) and the Contractor (or representative). If the Contractor objects to any measurements, a note must be made and signed by both parties. The Contractor must provide assistance for measurements without extra charge.

➤ **In Clause 6A**, the process is modernized with the introduction of a Computerized Measurement Book (MB). The Contractor is responsible for entering measurements into the Computerized MB, which is then checked by the Engineer-in-Charge. Corrections are made, and a final, accurate Computerized MB is submitted. The Contractor also submits computerized Abstract of Cost and bills based on the measurements. Assistance for checking measurements is provided by the Contractor without extra charge.

➤ **Clause 7** deals with payments. No payment is made for work.

➤ **Clause 8 - Completion and Site Cleaning:**  
Contractor must notify the Engineer-in-Charge within ten days of completing the work.  
Engineer-in-Charge inspects the work within thirty days. If no defects are found, a final certificate of completion is issued; otherwise, a provisional certificate is given listing defects to be rectified.  
Final completion is not recognized until the Contractor removes all scaffolding, surplus materials, rubbish, huts, etc., and cleans the premises.

➤ **Clause 8A - Site Cleaning During Maintenance:**

Requires immediate removal of splashes and droppings from whitewashing, painting, etc., upon completion of such work in individual rooms or premises.

If the Contractor fails to comply, the Engineer-in-Charge can have the work done at the Contractor's expense after giving ten days' notice.

➤ Clause 8B - Submission of Completion Plans:

Contractor must submit completion plans within thirty.

➤ Clause 9 - Payment of Final Bill:

Final bill submission must follow specified timelines.

After submission, no further claims can be made.

Payments for undisputed items and disputed items with approved quantities and rates must be made within six months.

Delayed payments incur a 10% per annum interest compounded yearly.

➤ Clause 9A - Payment through Banks:

Contractors can opt for payments to be made to their bank or recognized financial institutions.

The Contractor must provide proper authorization and acceptance of payment correctness.

Receipt from banks/institutions constitutes full payment discharge.

This clause applies only when specified in Schedule-F.

➤ Clause 10: This clause seems to cover various aspects related to materials to be supplied by both parties involved in the contract, the responsibilities of the contractor in procuring materials, the conditions for handling, storing, and returning materials, and the ownership of materials supplied.



# **PROJECT PERFORMANCE**

## **Site Clearance:**

- Area clearing before work starts, removing vegetation, shrubs, trees, etc.
- Setting benchmark pillars visible from the area.
- Contractor responsible for benchmark construction, connection, and maintenance.

## **Earthwork:**

- Site leveling and excavation/filling intervals recorded jointly.
- Soil classification for excavation types: all kinds, ordinary rock, hard rock, etc.
- Protections and precautions during excavation to prevent accidents.
- Blasting procedures require approval and compliance with safety regulations.
- Backfilling in foundation trenches with approved quality soil.
- Disposal and utilization of excavated earth as directed by the Engineer-in-Charge.

## **Earthwork in Filling:**

- Removal of top vegetation and types of soil for filling.
- Mode of filling and compaction control in layers.
- Measurements for earthwork in excavation and filling.
- Construction of road subgrades with suitable soil having a plasticity index (PI) between 5 and 20, with testing requirements.

## **Embankment Construction:**

- Materials like earth, moorum, gravel, or approved alternatives should be free of any deteriorating elements.

- Highly expansive clays should only be used at the bottom of the embankment.
- Foundations should be ploughed, leveled, and watered before work begins.
- Material sourcing from borrow pits or high ground should adhere to specified guidelines.

#### Anti-Termite Treatment:

- Chemical treatment to protect against subterranean termites must follow specific standards and be done by approved specialized agencies.
- Materials like Heptachlor emulsifiable concentrate or Chlorpyrifos emulsifiable concentrate should be used as specified.

#### Masonry Works:

- Brick specifications include quality, size, water absorption, and crushing strength.
- AAC (Autoclaved Aerated Concrete) thickness should match drawings, with approved samples required before bulk purchase.
- Mortar, construction details, bonding, joint thickness, curing, and measurements are all specified in detail for brickwork and AAC.

#### Random Rubble Masonry:

- Stone selection should be hard, durable, free from defects, and sourced from approved quarries.
- Mortar and curing specifications apply, with measurement based on cubic meters.

### **Concrete Works:**

- Scope covers various types of concrete used in foundations, underground, and overground structures.
- Materials like cement and fine aggregates must meet specific standards, with testing certificates required.
- The formwork, steel reinforcement, woodwork, hardware, aluminium/steel work, waterproofing, and flooring are essential components of any construction project.

### **Formwork (Shuttering):**

Formwork must be rigid, made of steel and/or plyboard, and joints should prevent concrete leakage. It should be properly aligned and braced to support concrete during placement. The surfaces should be clean, watertight, and smooth, with suitable devices to hold corners and edges together.

### **Steel Reinforcement**

Only Fe500 Super Ductile reinforcement steel should be used, conforming to specified standards. Reinforcement bars must be cleaned of rust, dust, and other deleterious substances before placement. They should be accurately placed, secured, and supported to maintain correct position and cover.

### **Woodwork:**

Timber for woodwork should be kiln-seasoned and chemically treated. Tolerances for door frames, shutters, and other woodwork components are specified. Samples of species used should be approved by the Engineer-in-charge.

### **Hardware:**

All doors and windows should be fitted with necessary hardware, fittings, and fixtures, of approved quality and size. Special attention is given to door hinges, locks, and other

fittings, with samples required for approval before bulk purchase.

### **Steel/Aluminium Work**

Steelwork should be welded and painted as per specifications, while aluminium doors, windows, and ventilators should be provided with approved sections, anodized finish, and fittings.

### **Waterproofing:**

Different waterproofing methods are specified for roofs, terraces, and sunken floors. This includes the application of polymer-based coatings or cementitious compositions, ensuring surfaces are clean and treated before application.

### **Flooring:**

Cement concrete flooring should be laid as per specified thickness and mix, with proper sub-base preparation, curing, and jointing. Vitrified tiles should conform to specified standards and be laid with proper surface preparation, mortar bedding, and jointing.

### **Painting:**

All pipes, ducts, whether underfloor or exposed, must undergo a meticulous painting process. This entails applying a minimum of three coats of paint, ensuring complete coverage and protection. The paint used must be of an approved shade and high-quality to ensure durability and aesthetic consistency throughout the installation.

It's important to note that no additional payment will be allocated for this painting work, as it is considered an integral part of the installation process, necessary for both functional and aesthetic purposes.

# **ELECTRICAL SPECIFICATIONS**

It will be the Contractor's responsibility to determine the exact quantities from the worksite, based on drawings or suggested equipment, materials, tools, and labor.

- The bidder shall supply, install, and commission, along with requisite spare maintenance tools and tackles, the following equipment and systems in the Building. The scope also covers the detailed engineering and calculations of the various equipment/systems mentioned hereunder, which shall be approved by the Engineering-In-Charge prior to the execution of the job:
  - Lightning protection system.
  - Capacitor with control panels.
  - Conduiting for Fire Alarm and Public Address System.
  - Rising Main/Distribution Boards/Sub-Distribution Board.
  - Complete internal building wiring as per specifications.
  - Safety to personnel and equipment during both operation and maintenance.
  - Reliability of Service.
  - Minimum fire risk.
  - Ease of maintenance and convenience of operation.
  - Automatic protection of all electrical equipment through selective relaying system.
  - Electrical supply to equipment and machinery within the design operating limits.
  - Adequate provision for future expansion and modification.
  - Maximum interchangeability of equipment.
  - Fail-safe feature. Suitability for applicable environmental factors.

This specification prioritizes safety, reliability, efficiency, and adaptability, ensuring that the electrical system meets the requirements of the building and its occupants while conforming to industry standards and environmental considerations.

## **EQUIPMENTS USED IN THE PROJECT**

- 1 Graduated glass measuring cylinder
- 2 sets of sieves of 450mm internal diameter for coarse aggregate [40mm; 20mm; 12.5mm; 10mm; 4.75mm complete with lid and pan]
- 3 sets of sieves of 200mm internal diameter for fine aggregate [4.75mm; 2.36mm; 1.18mm; 600 microns; 300 microns; 150 microns, with lid and pan]
- Sieve brushes and sieve shaker capable of 200mm and 450mm diameter sieves, manually operated with timing switch assembly
- Slump cone, steel plate, tamping rod, steel scale, scoop
- Physical balance
- Electronic balance – 25kg/10kg capacity sensitive to 1gm
- Electronic balance – 200gm capacity sensitive to 0.01gm
- Vernier calipers.
- Digital pH meter (LC 0.01mm)
- Digital micrometer (LC 0.01mm)
- Digital paint thickness meter for steel 500 micron range
- GI tray 600x450x50mm, 450x300x40mm, 300x250x40mm
- Screw gauge 0.1mm-10mm, least count 0.05mm
- Water testing kit
- Cube testing machine (100MT)

## **PLANTS AND MACHINERY USED IN THE PROJECT**

- RMC plant CP30 or equivalent: 2 units
- Transit Mixer (5-6 cum): 8 units
- Boom Placer/Pump: 1 unit
- Static Concrete Pump: 2 units
- Builder's Hoist: 1 unit
- Excavators: 4 units
- Scaffolding/Staging material (steel): As per requirement
- Tipper: 4 units
- Total Station: 1 unit
- Earth Rammer/Soil Compactor: 1 unit
- Curing Pumps: 4 units
- Welding Machine: 4 units
- Vibrators: 10 units
- DG Set: As per requirement
- Screener for coarse & fine sand: 4 units
- Reinforcement cutting machine: 8 units
- Chase cutting machines: 4 units
- Portable Ordinary drilling machine: 5 units
- Tile cutting machine: 8 units.

# **CHALLENGES FACED IN THE PROJECT**

## **1. The land was marshy so piling was used before construction to provide stability :**

- **Soil Stability:** Piling solve this problem by providing a stable foundation that bypasses the weak surface soil.
- **Driving Piling:** The driving process can be difficult due to the soft ground, but properly designed pilings and driving techniques can overcome this. However, improper driving techniques can further destabilize the marsh.
- **Waterproofing:** Even with pilings, water can still be present around the base of the structure. Careful waterproofing is needed to prevent leaks.
- **Environmental Impact:** The process of driving pilings can disturb the marsh environment. Choosing the right piling type and driving method can help minimize this impact.

## **2. Backfilling of pond :**

- **Extra backfilling is provided:** The type of soil in the pond bed and the surrounding area will influence the backfill process. Clay soils, for example, may retain water and require additional drainage solutions.
- **Settlement:** The backfilled area will likely settle over time, especially if organic materials were present in the pond bed. This might require adding more fill material later on.



**3. Rerouting of road was done as it was intersecting the construction area.**

**4. Shear wall is provided to withstand the load and to reduce the dimension of the column and utilise the space.**

**5. Additional water pump is provided to transport water from first floor to the tenth floor to maintain uniform pressure.**



## **CONCLUSION**

The findings of this project underscore the importance of careful planning and strategic decision-making in managing the financial aspects of a construction project of this scale. By accurately estimating costs and identifying potential cost-saving opportunities, stakeholders can mitigate risks, optimize resources, and ensure the successful execution of the project within budgetary constraints. Through meticulous analysis of various factors such as materials, labour, equipment, permits, and contingencies, we have generated realistic projections.

In closing, I would like to express my gratitude to all team members who contributed their expertise, dedication, and support to the success of this project as well our team like to thank Dr. Santu Kar course instructor of CE308 for giving us this wonderful project which helped us to learn and understand many new concept of construction technology and management (CE 308) . Together, we have demonstrated the power of teamwork, innovation, and perseverance in achieving our goals.

## **THANK YOU !!!**

