The Agreement or Contract...

- The agreement is the legal document signed by the owner and the builder that outlines the terms under which the project will be built.

- It includes such items as cost, time, management, reports, quality, penalties and all such details that define the owner’s “intent”.

The Specifications...

- Define the “qualitative” requirements of the project that is to be built.

- Provide a detailed description of the performance features of all components of the project.

- Describe the nature of the materials and the workmanship & procedures to be followed in constructing the project.

- Include those aspects of assembly or construction that affect the performance of the components.

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Construction Engineering
Class #6: Plans & Specifications
Prof. Ralph V. Locurcio, PE

Contract Documents...

1. The Agreement or Contract
2. The Specifications
3. The Drawings

Important Note:

Unless otherwise specified this list is the “order of precedence” of the contract documents
Conflicts between plans & specs...

- The specifications take precedence over the plans.
- The contract or the specifications may state otherwise.
- Builder must notify the owner’s rep of any conflict he encounters.
- Owner’s rep or inspector must know the specs and observe the work.

The Drawings or Plans...

- Define the "geometry" of the project and all of it’s components.
- Include the general form, dimensions and details of all project features that are to be fabricated on site.
- Show the relationship of all components to each other.
- May include details, notes and instructions that amplify the specifications.

Components of a spec...

- Instructions to bidders:
  - May be part of General Conditions
  - Proposal & bid format
  - Bonding & certificates
  - Affidavits

- General conditions:
  - Contract administration
  - Correlation of documents
  - Authority of parties
  - Supervision
  - Payment
  - Damages
  - Disputes

- Technical provisions
  - Installation or fabrication instructions
  - Materials & performance criteria

Agreement of plans & specs...

- Plans are frequently updated as the design progresses.
- Specifications may be written independently of the plans.
- Specifications are very complex and detailed; some changes are missed.
- Specifications are often prepared by different authors.
- Master or standard specifications may have been used.
- Project budget may not allow for proper coordination of plans & specs.
Shop Drawings & Samples...

- Function of Shop Drawings
  - Link between design & construction
  - Show details of fabrication, assembly & installation
  - Allow introduction of commercially tested products
  - Show method of accomplishing "special" requirements
  - Contracts usually require approval prior to ordering

- Approval of Shop Drawings
  - Contract SPs usually specify list of shop drawings
  - Builder must submit schedule of submissions
  - Owner must "approve" submittals for conformance to specs
  - Builder responsible for accuracy, means & methods, quality

- Misuse of Shop Drawings
  - Submissions may not change contract requirements or design intent
  - Builder's responsibility to conform, even if missed by AE/Owner review

CSI Format...

1. General requirements
2. Site work & utilities
3. Concrete
4. Masonry
5. Metals
6. Wood & plastics
7. Thermal & Moisture Prot.
8. Doors & windows
9. Finishes
10. Specialties
11. Equipment
12. Furnishings
13. Special construction
14. Conveying systems
15. Mechanical
16. Electrical
17. Instrumentation & Controls

See pp.156-157 Fisk for detailed breakdown

Stopping the work...

- Work is defective...
  - Owner’s right to stop work that is defective
  - Contract provisions govern
  - Communicate in writing
  - Contractor may dispute

- Unsafe conditions...
  - Risk of death or serious injury
  - Obligation of Owner’s rep and Builder
  - Follow verbal order with written order

- Risk of stopping work...
  - Cost incurred for labor & materials
  - Schedule slippage might incur damages
  - Work must be torn out and rebuilt

Differing Site Conditions...

- Unforeseen underground conditions
  - Latent physical conditions; unknown or unusual
  - Differ significantly from printed contract docs or data
  - Require increased work not included in bid

- Architects responsibility in design
  - Make "reasonable" subsurface investigations
  - Advise builder of all available data & design assumptions
  - Not responsible for 100% accuracy

- Builder's responsibility in bidding
  - Not expected to perform subsurface investigation
  - Become familiar with all conditions of site
  - Cover risk with pricing & contingency

- Federal Guidelines
  - Pay for reasonable "compensable" conditions
  - Reduces bidder’s risk & contingencies in contract

- Sharing the risk
  - Parties agree to a formula in contract documents
Participants & Responsibilities...

- The Owner
- The Designer
- The Builder
- The Construction Manager

Drawings in standard set...

- Architectural
- Site utilities & civil
- Electrical
- Mechanical
- Fire protection
- Finish schedules
- As-built/record drawings

The Owner...

- Pays for the project
- Accepts the project on completion
- Sets criteria for design
- Sets cost parameters
- Establishes time line for completion
- Determines contract type
- Hires the designer & builder
- Appoints the construction manager
- Makes decisions when needed

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Construction Engineering
Class #7: Preconstruction Operations
Prof. Ralph V. Locurcio, PE
Construction Manager...

- Represents the owner in all matters
- Oversees construction operations
- Monitors schedule & costs
- Provides interface with client operations
- Enforces contract provisions
- Makes decisions on changes or claims
- Approves progress payments
- Performs quality assurance
- Accepts completed work

The Designer...

- Oversees planning & advises owner
- Evaluates siting options
- Develops concept design
- Prepares contract plans
- Prepares contract specifications
- Prepares cost estimates
- Prepares bid package
- Assists in selection of builder
- Assists during construction

The Project Delivery Process...

1. Owner identifies need for new facility
2. Owner appoints Project Manager
3. Project Manager develops project program & scope
4. Owner summarizes program
5. Project is awarded to appropriate operation
6. Project manager reviews & approves contract

The Builder...

- Prepares and submits bid documents
- Organizes project team
- Hires & pays subcontractors
- Obtains permits and licenses
- Mobilizes contract work force on NTP
- Builds IAW plans & specifications
- Controls quality & cost
- Manages construction site & safety
- Turns over completed project on time
Typical award schedule (text p284)... 

- Public agency - est. days ( ):
  - Obtain bid opening dates from owner (1)
  - Print specs (3)
  - Duplicate plans (5)
  - Prepare notice inviting bids (7)
  - Plans & specs avail for pick-up (9)
  - 1st Advertisement appears (20)
  - 2d Advertisement appears (27)
  - Pre-bid meeting (31)
  - Open bids (37)
  - Evaluation of bids (44)
  - Recommendation of award to city council (45)
  - Award by city council (50)
  - Execute contract agreement (65)

Project Organization...

Issuance of Bid Documents...

- Prepare adequate bid sets
  - Make "reproducible" set of Mylar drawings
- Plan bidding process carefully
  - May issue pre-bid notice
  - May include pre-bid conference to clarify owner's intent
  - Issue amendments to correct errors
  - Avoid "irregularities"
  - Documents are "close hold" to ensure competition
- Issue bid documents
  - All sets must be identical
  - Keep accurate log of documents issued
  - Addenda must be mailed to all bidding firms
  - Answers to questions to all bidders
- Bid protest
  - Process stopped pending review
  - May be cause for rebid
  - Financial problems result

Preconstruction Planning Factors...

1. Long-lead items
2. Utility interruptions
3. Temporary utilities
4. Labor
5. Work/storage areas
6. Traffic
7. Temporary access
8. Other contracts
9. Interdependent tasks
10. Environmental controls
11. Special regulations
12. Const equipment
13. Construction timing
14. Owner's operations
15. Building codes
16. Permits required
Bid Opening & Evaluation...

- Technical evaluation & review
  - Will bid achieve owner's intent
  - Is bidder's plan competent & safe
  - Are subcontractors qualified

- Price evaluation
  - Rank order by low to high bid
  - Are all bids "responsive"; i.e., meet all requirements
  - Bids may not be "qualified" in any way
  - Review of "schedule of values" or estimated payment schedule
  - Determine "apparent" low bidder

- Bid qualification
  - Is bidder disqualified for any reason
  - Are bonds, insurance & certifications adequate

- Recording of bids & recommend award

Bonds...

- Bid bonds
  - Avoids loss if bidder cannot/does not accept contract
  - 5%-10% of bid price
  - Returned when agreement signed
  - Common on public contracts
  - Bonds purchased from "surety" company

- Performance & payment bonds
  - Intent is to protect owner from contractor failure
  - Insurance (surety) company guarantees completion
  - Payment bond pays labor & material debts of contractor
  - Prime often requires bonds of subcontractors
  - Ability to obtain bonds depends on prior performance

Quality Control & Assurance...

- Quality control vs. quality assurance
- Required on government contracts

- Inspection & Testing manual
  - Policy matters that govern acceptance
  - Inspection procedures
  - Technical checklists
  - List of testing for materials & equipment
  - Work flow diagrams

Insurance...

- General liability insurance
  - Operations
  - Personal injury
  - Liability during construction
  - Automobile medical & physical payments
  - Post-project liability

- Builder's Risk Insurance
  - Covers perils during construction
  - Fire, lightning, vandalism, windstorm
  - Additional perils: collapse, terrorism, rupture, etc...
Submittal Review...
- Include: shop drawings, samples, test results, certifications, criteria & standards
- List is prepared by designer
- Approval by owner’s rep – verify conformance & suitability
- Timing of approval is essential
- Special attention: blasting, excavation, compaction, water control, pile driving, hazmat, cranes

Inspection & Testing Manual...
- Detailed inspection procedures:
  - Preparatory inspection: work flow, submittals, methods
  - Initial inspection: workmanship & components
  - Follow-up: results of work, tests, appearance
- Acceptance/rejection criteria
- Testing requirements & frequency
- Responsibilities for testing
- Approval of outside labs & testing agencies
- Timing of inspections & work
- Reports required, frequency & format
- Documentation of test results

Submittal Process...

Inspection Process (text p304)...
Stopping the work...

- Work is defective...
  - Owner’s right to stop work that is defective
  - Contract provisions govern
  - Communicate in writing
  - Contractor may dispute

- Unsafe conditions...
  - Risk of death or serious injury
  - Obligation of Owner’s rep and Builder
  - Follow verbal order with written order

- Risk of stopping work...
  - Cost incurred for labor & materials
  - Schedule slippage might incur damages
  - Work must be torn out and rebuilt

The Partnering Process...

- The purpose: establish working relationships early in the project to facilitate work progress
  - Implement via workshop @ NTP
    - Clarify roles & responsibilities
    - Issue resolution process
    - Measurement & evaluation process
    - All sign partnering “charter”

- Key elements: trust, equity, strategy
- Requires commitment of all players
- All sign a “Project Charter”
- Measurement & periodic follow-up essential

Quality Control Process...

- Must have a Quality Control Plan... an inspection” system”

- Special considerations:
  - Timing of inspections; preclude delays
  - Protection of work in place
  - Most work is irreversible; i.e., concrete, foundations
  - Logistical sequencing
  - Follow plans & specifications; changes not authorized
  - Report and correct errors & deviations from spec; documents

- Three phased inspections system
  - Preparatory inspection
  - Pre-inspection
  - Final inspection

- QC Staff must be qualified, trained & dedicated

Shop Drawings & Samples...

- Function of Shop Drawings
  - Link between design & construction
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- Misuse of Shop Drawings
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CPM in Construction...
- Tasks are not all consecutive
- Need to show interdependencies
- Need to identify critical tasks & timing
- Need to show slack or float
- Need to see tasks superimposed
- Need to chart progress & payment

Construction Scheduling...
- Common methods:
  1. Bar Charts
  2. Velocity Charts
  3. Network Diagrams: CPM/PERT
  4. Line-of-Balance Charts

Contracts...
- What is a contract?
  - Basically... it's an offer and an acceptance between two parties.
  - In construction... it's a promise made by the owner and a reciprocal promise by the builder.
  - In our culture, contract is enforceable by law.
  - Essentially a business tool to control risk.

Characteristics of methods...
- Bar Charts
  - Simple & easy to read
  - Based on contractor field experience
  - Do not show interdependencies
  - Do not show critical path
- S-Curves
  - Good for showing progress
  - Do not show interdependencies
  - Do not show critical path
- Line-of-Balance
  - Show interdependencies
  - May show progress
  - Do not show critical path
Lump-sum contract...

- Most common... “low bidder” contract
- A “fixed-price” contract
- A set scope of work for a set price
- Only changes are via change order
- Requires complete set of plans & specifications \(\rightarrow\) the “scope of work”
- Selection via competitive bidding
- Easiest to administer
- Final price is known at time of award
- A home run for the owner

Two general types...

- Fixed price contracts...
  - Scope is known
  - Price is fixed by competition
  - Changes only by contract modification
  - Easiest to award and administer
- Cost-reimbursable contracts...
  - Scope is variable or unknown
  - Price varies with work accomplished
  - Changes are frequent
  - Difficult to award and administer

Unit-price contract...

- Modified form of “fixed-price” contract.
- Based on measurable construction units.
- Unit prices for tasks are fixed.
- Contract scope is the total list of tasks.
- Specifications govern quality.
- Unspecified tasks must be negotiated.
- Used for pipelines, roadways, tunneling, etc.
- Ultimate quantities purchased may be unlimited, or limited only by time.
- Used when total quantity unknown or unlimited.
- Called “Indefinite Quantity” or IDQ contracts

Construction contracts...

- Lump-sum
- Unit-price
- Fixed-price with incentives {\(\text{Fixed Price}\)}
- Cost-reimbursable
- Time & materials (T&M)
- Cost-plus-fixed-fee (CPFF)
- Cost-plus-incentive fee {\(\text{Cost Plus}\)}
- Guaranteed Maximum Price (GMP)
Time & materials contracts...

- Used when scope is completely unknown and there is no time to design
- Owner assumes all of the risk
- Easy to write; difficult to administer
- End price is unknown
- Sometimes includes “upset” amount
- Contractor can make substantial profit

Fixed-price incentive contract...

- Same as fixed-price
- But... profit is adjusted based on performance
- Incentive formula must be clearly specified in contract documents
- May have price ceiling
- Requires periodic performance “rating” during execution
- Requires close supervision to ensure contractor hits performance target

Cost-plus-fixed-fee...

- Actual costs paid for labor & materials
- Overhead rate generally fixed
- Fee is a “fixed” dollar amount that is specified in contract documents
- Generally used when scope of work is known but no time to design
- Contractor shares some risk
- Provides owner some control

Time & materials contracts...

- Contractor is paid his actual costs for labor & materials plus a 15% ± mark-up for overhead
- Contract documents define eligible costs such as labor categories, travel, rentals, permits, fees, other expenses...
- Contractor must supply invoices for all expenses and certified time sheets for labor
- Audit of contractor operations is essential
- Profit is specified 10% ± mark-up of costs
- Also called Cost-plus-percentage-of-cost
Two broad types of estimates...

- Conceptual
  - Used for early decisions & feasibility
  - Rough estimate using minimal data
  - Relies heavily on past data
  - Level of accuracy about 70%

- Detailed
  - Used for major decisions; i.e. bids & budgets
  - Based on final design documents
  - Level of accuracy up to 95%

Guaranteed maximum price...

- Generally used in design-build work
- Contractor agrees to deliver facility for a fixed maximum price
- Contractor assumes all the risk and keeps all the savings
- Owner provides “performance” spec
- Contractor has maximum flexibility to use creativity and market dynamics
- Good for known standards, industrial or commercial work

Cost-plus-incentive-fee...

- Similar to cost-plus-fixed-fee
- Contractor is paid an additional fee or bonus if certain specified conditions are met, such as time, cost or satisfaction of user
- No bonus if conditions not met
- Incentive minimizes risk to owner
Estimating process...

1. Determine project characteristics: **Scope, constructability, risk**
2. Examine the project design
3. Structure the estimate
4. Determine elements of cost
5. Calculate estimate

Conceptual types:

- Based on prior experience:
  - Weight check... weight of equipment
  - Cost-capacity factor- ratio of Q/$
  - Comparative cost of structure – $/unit
- Feasibility estimates
- Appropriations estimates
- Time & location adjustments

Determine elements of cost...

- **Labor**- craft & skill resources; sub-contractors; union labor; wage rates; training; “effective” labor rates; productivity factors (weather, complexity, experience, management)
- **Material**- price, shipping, availability, storage, relation to specifications
- **Equipment**- purchase vs. lease, single use, down time, cost of maintenance
- **Capital**- interest rates, payment flow, retainage
- **Time**- overhead costs, required completion date,

Detailed estimates...

- Based on three primary factors:
  
  **A. Scope... quantities**
  
  **B. Constructability... methods**
  
  **C. Risk... externalities**
Change order defined...

- A written agreement to modify, add to or otherwise alter the work, timing or payment set forth in the original contract documents, for an agreed upon sum or compensation, which is signed by both parties to the original agreement.

Reasons for changes...

- Change of purpose or need...
- Changes to methods or manner of work...
- Correct errors or omissions...
- Differing site conditions...
- Value engineering...
- Contractor suggestions...
- Almost any other reason not envisioned when the original contract was written.

Calculate the estimate...

- Material take-off from plans
  1. Quantities of all construction materials
  2. Compare with specifications
- Labor cost for construction or installation
  1. Effective labor rates
  2. Team composition & duration
- Construction equipment schedule
  1. On hand vs. lease or purchase
  2. Time on job
- Follow elements of cost
  1. Ensure all items are covered

CVE 4070

Construction Engineering
Class #14: Changes & Extra Work
Prof. Ralph V. Locurcio, PE
Change order process...

Types of change orders...
- Oral change orders
- Written and/or directed change orders
- Bilateral change orders
- Unilateral change orders
- Constructive change orders

Change order process...
- Identification of need for change
  - May be initiated by owner or contractor
- Initiator prepares detailed scope
- Justification for change is approved by owner
- Submitted to designer of record for approval
- Cost of change is negotiated
- Owner agrees & signs change document
- Notice to proceed is issued to contractor