The quality control measures in construction projects

- Creating quality consciousness.
- Setting up site material testing laboratory and establishing other sources for materials testing.
- Training the concerned staff.
- Implementing quality plan.
- Testing incoming and locally produced materials.
- Monitoring quality performance.
- Investigating cases relating to quality failure to prevent recurrence.
- Formulating plan for re–work when needed.
- Feedback quality performance for effecting improvements.

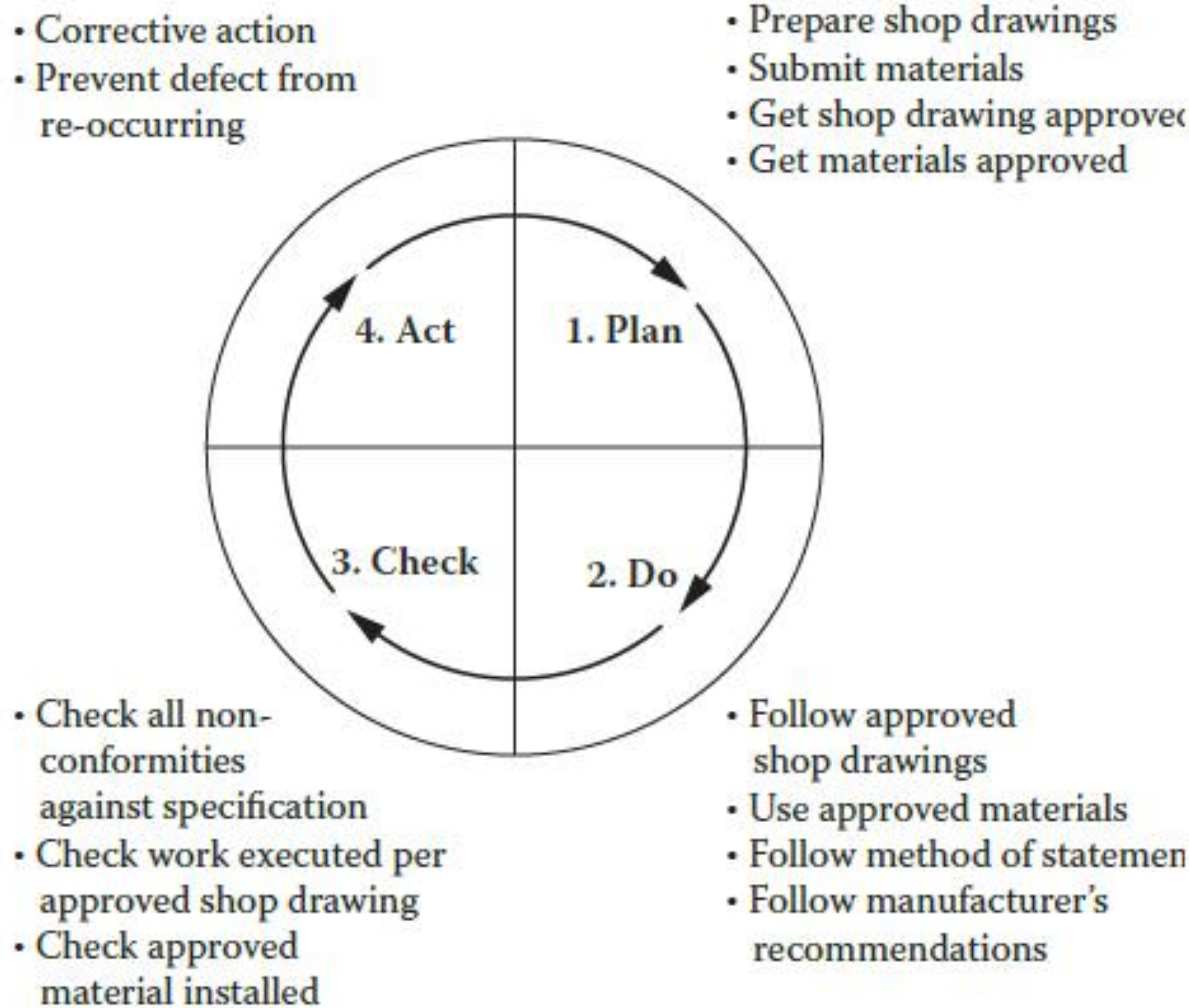


FIGURE 4.80
PDCA cycle for execution of works.

Content of Contractor's Quality Control Plan

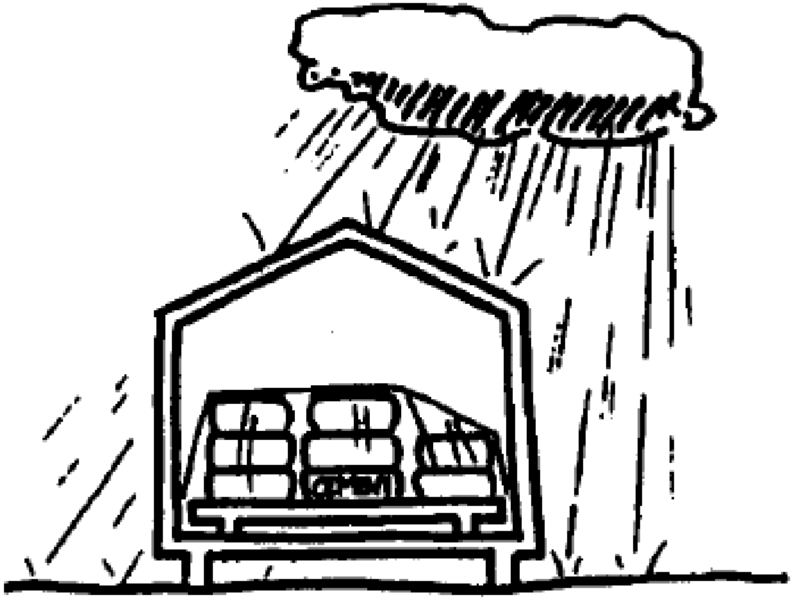
- 1.0 Introduction
- 2.0 Description of project
- 3.0 Quality control (QC) organization
- 4.0 Qualification of QC staff
- 5.0 Responsibilities of QC personnel
- 6.0 Procedure for submittals
  - 6.1 Submittals of subcontractor(s)
  - 6.2 Submittals of shop drawings
  - 6.3 Submittals of materials
  - 6.4 Modification request
  - 6.5 Construction program

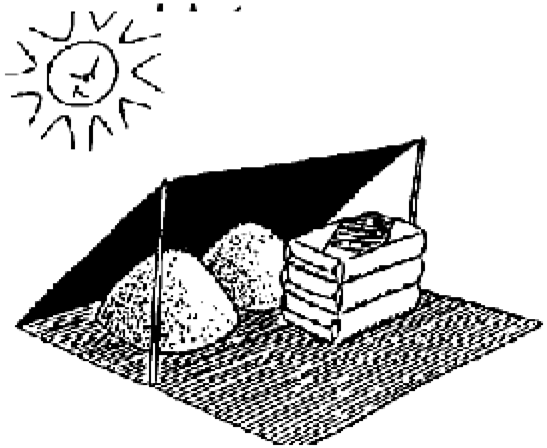
- 7.0 Quality control procedure
  - 7.1 Procurement
  - 7.2 Inspection of site activities (checklists)
  - 7.3 Inspection and testing procedure for systems
  - 7.4 Off-site manufacturing, inspection, and testing
  - 7.5 Procedure for laboratory testing of material
  - 7.6 Inspection of material received at site
  - 7.7 Protection of works
  - 7.8 Material storage and handling
  - 8.0 Method statement for various installation activities
  - 9.0 Project-specific procedures

- 10.0 Quality control records
- 11.0 Company's quality manual and procedures
- 12.0 Periodical testing
- 13.0 Quality updating program
- 14.0 Quality auditing program
- 15.0 Testing, commissioning, and handover
- 16.0 Health, safety, and the environment (HSE)

Quality Control Plan For Concrete

1	Concrete Slump	As Per Contract Specification	80mm - 120mm	Every Consignment
2	Concrete Temperature	As Per Contract Specification	Not More than 30 ċ	Every Consignment
3	Cube Strength, 3 days	As Per Contract Specification	Not Less Than 20 Mpa	One Set For Every 75 Cum
4	Cube Strength, 7 days	As Per Contract Specification	Not Less Than 30 Mpa	
5	Cube Strength, 28 days	As Per Contract Specification	Not Less Than 40 Mpa	



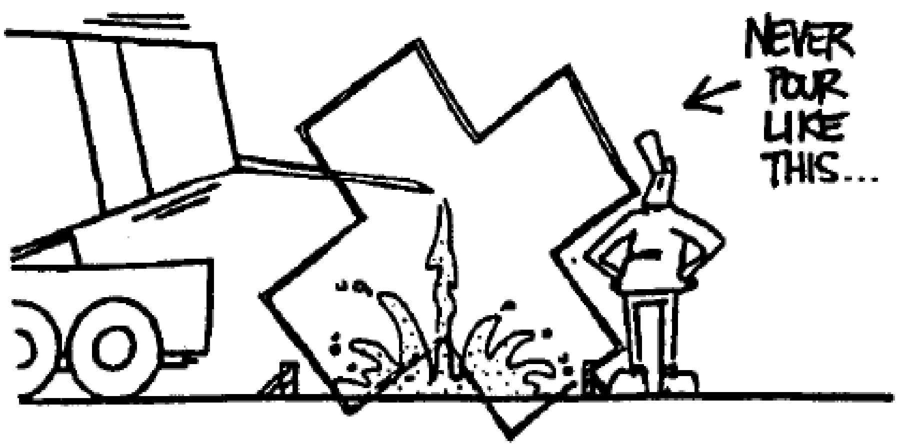


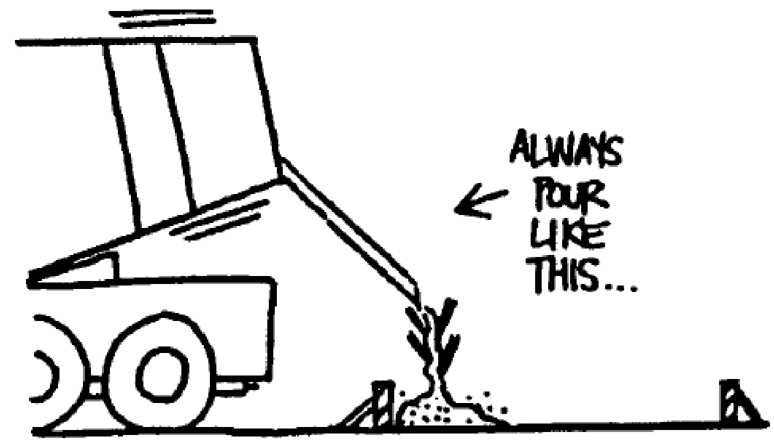

HINDUSTAN

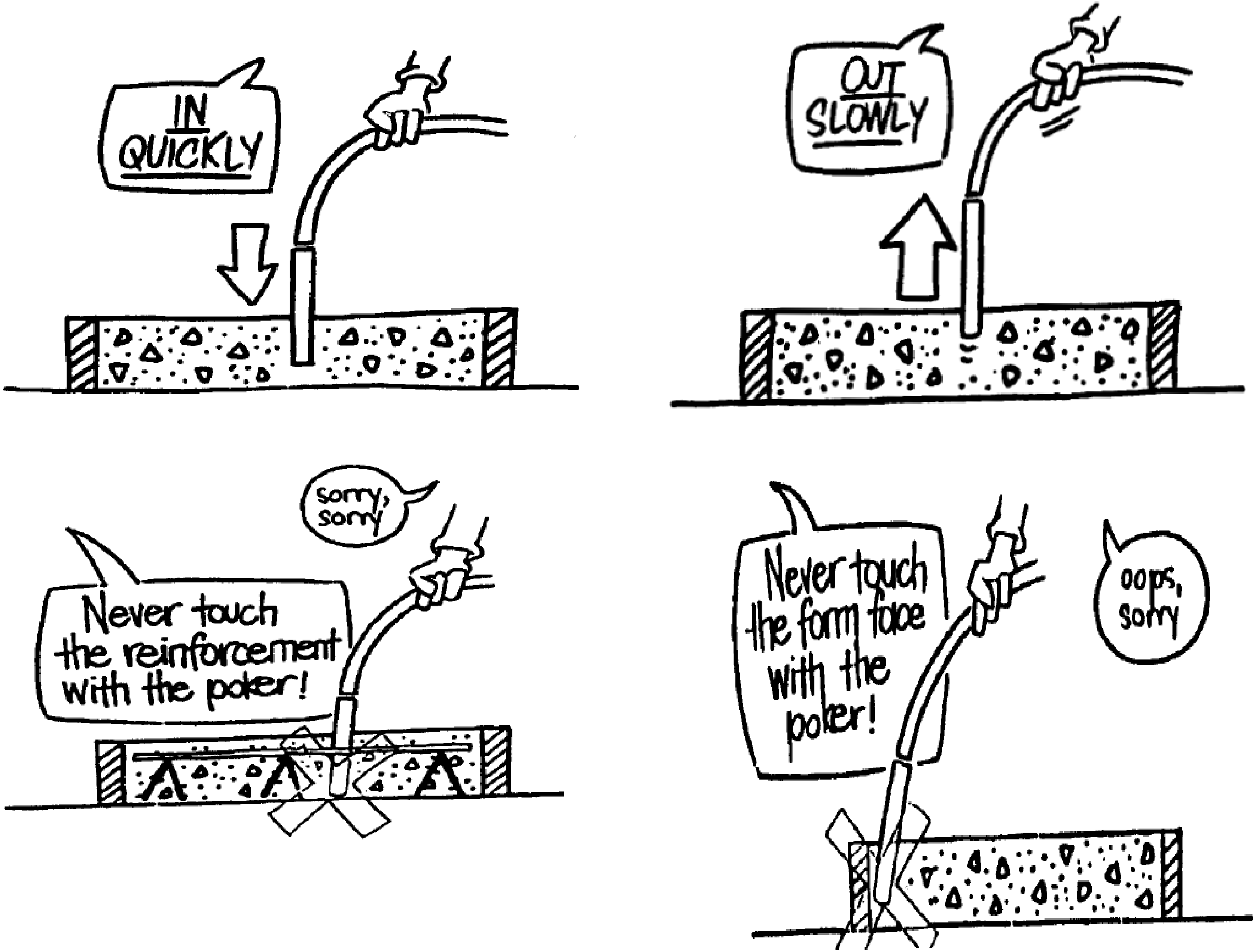

TOO SLOPPY OR WET!

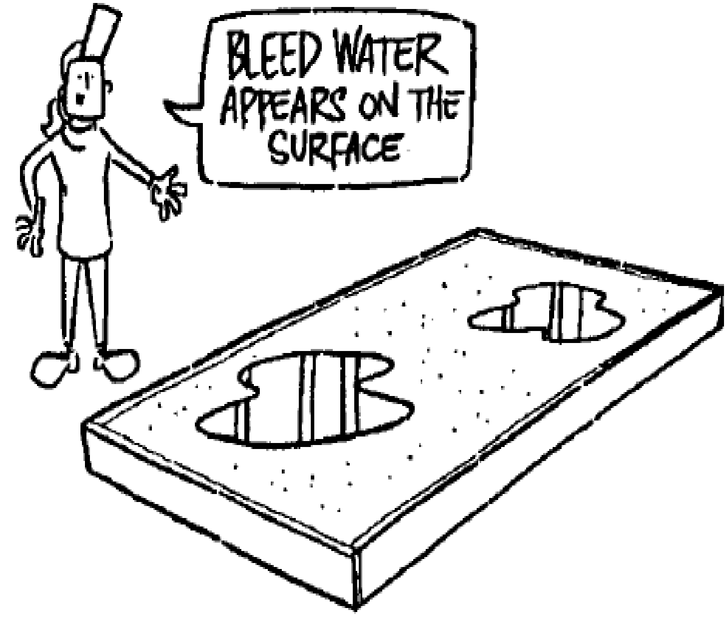

TOO STIFF OR DRY!
CRUNCH!

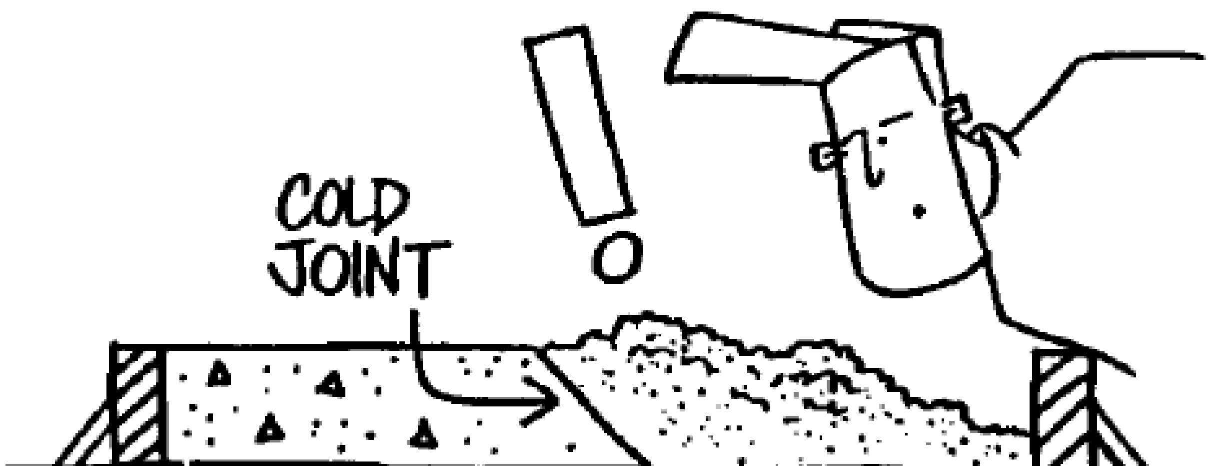

IF YOU CAN DRINK THE WATER IT'LL BE O.K. TO USE

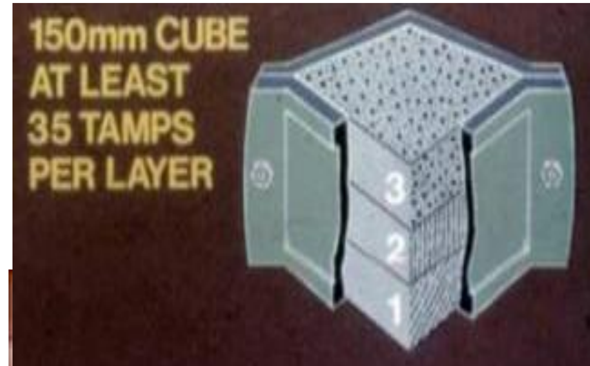

NEVER POUR LIKE THIS...


ALWAYS POUR LIKE THIS...


IN QUICKLY
OUT SLOWLY
sorry, sorry
Never touch the reinforcement with the poker!
Never touch the form face with the poker!
oops, sorry


BLEED WATER APPEARS ON THE SURFACE


COLD JOINT


150mm CUBE
AT LEAST
35 TAMPS
PER LAYER
3
2
1

REINFORCEMENT

1. Unit weight
2. Ultimate tensile strength
3. Yield strength
4. % Elongation
5. Bend & rebend test
6. Chemical Test

TESTING GROUPS

- 1. Mixtures (i.e., concrete, soil)
- 2. Connections (i.e., welding, bolts)
- 3. Assemblies (i.e., curtain walls, roofs)
- 4. Material (i.e., steel, cement, aluminum, glass)
- 5. Load capacity (i.e., piles, concrete cylinders, steel)
- 6. Pressures (i.e., pipes, duct work)
- 7. Flow (i.e., air balancing, water balancing, sprinklers)
- 8. Systems (i.e., life safety, electrical)
- 9. Performance (i.e., elevators, mechanical equipment, electrical equipment)

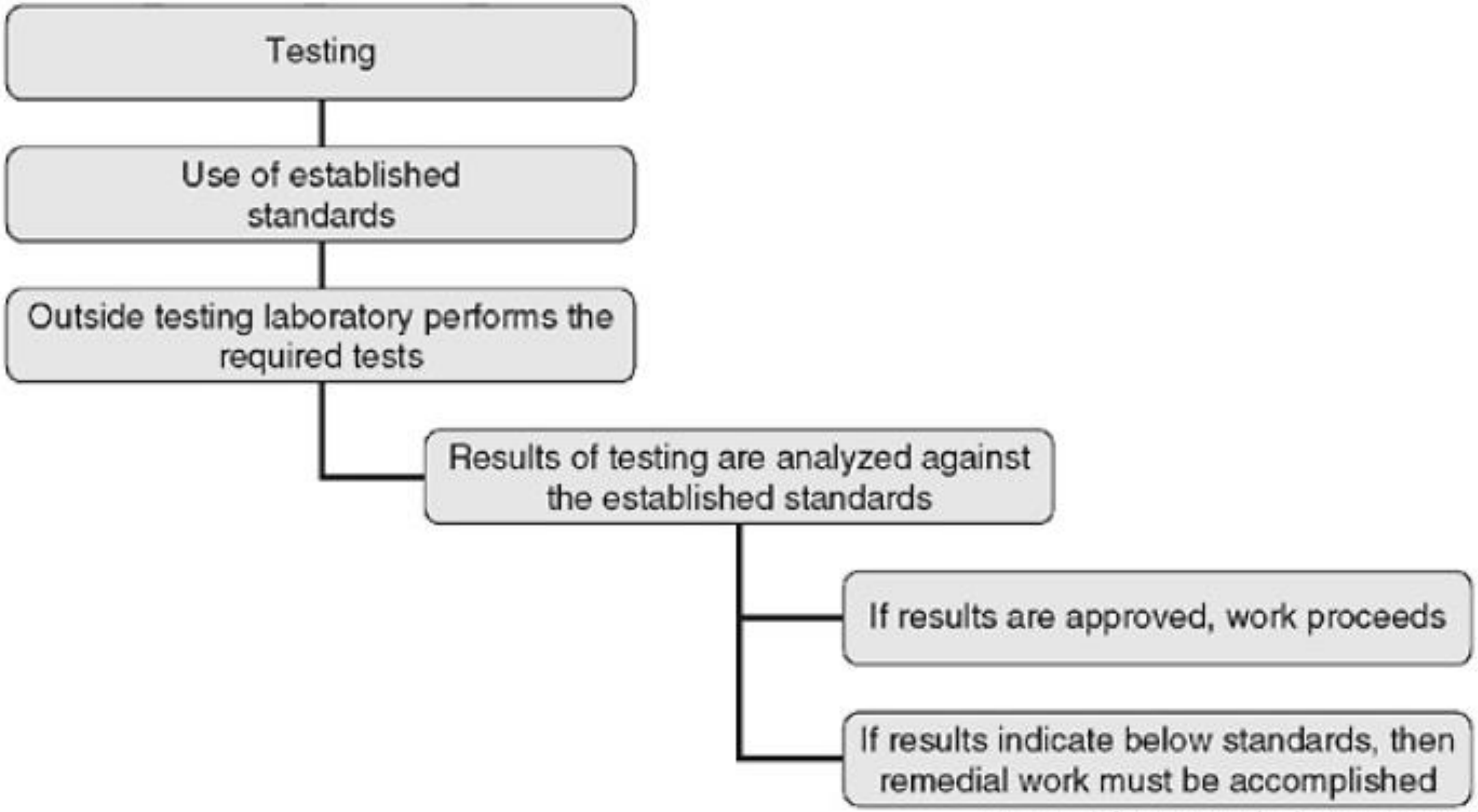


Figure . Exhibit 3-1 Testing flowchart.

Table . Exhibit 3-2 Testing procedure organizations.

The following is a list of organizations (not inclusive) that have testing as part of their specifications:	
1.	ACI (American Concrete Institute) —http://www.concrete.org/general/home.asp
2.	AISC (American Institute of Steel Construction)—http://www.aisc.org/
3.	ASTM (American Society of Testing and Materials)—http://www.astm.org/
4.	NEC (National Electrical Code) —http://www.nfpa.org/catalog/product.asp?pid=7008SB&src=nfpa&order_src=A292
5.	ASHRAE (American Society of Heating Refrigeration Air Conditioning Engineers) —http://www.ashrae.org/
6.	IBC (International Building Code) —http://www.iccsafe.org/
7.	NFPA (National Fire Prevention Association) —http://www.nfpa.org/
8.	UL (Underwriters Laboratories Inc.) —http://www.ul.com/

	depending upon location
10.	ANSI (American National Standards Institute)—http://www.ansi.org/
11.	AWS (American Welding Society) —http://www.aws.org/w/a/
12.	SMACNA (Sheet Metal and Air Conditioning Contractors National Association) —http://www.smacna.org/
13.	ASME (American Society of Mechanical Engineers) —http://www.asme.org/
14.	SIGMA (Sealed Insulating Glass Manufacturers Association)—401 N. Michigan Ave., Suite 2400, Chicago, IL 60611; (312) 644-6610
15.	AAMA (American Architectural Manufacturers Association) —http://www.aamanet.org/
16.	FM (Factory Mutual) —http://www.fmglobal.com/
17.	NEMA (National Electrical Manufacturers Association) —http://www.nema.org/
18.	NIST (National Institute of Standards and Technology) —http://www.nist.gov/
19.	PCI (Precast/Prestressed Concrete Institute) —http://www.pci.org/intro.cfm
20.	ASCE (American Society of Civil Engineers) —http://www.asce.org/asce.cfm

	Type of Field Test Required	Local Building Code Section	Specification or Industry Standard Section	Date Inspected	Location	Inspector's Name	Pass/ Fail	Comments
1. Site								
Environmental Phase I	Report prepared based on existing available information provided by the local EPA, local fire department, coast and geodetic survey indicating the locale of potential hazardous waste sites and/ or reported spills.							
Environmental Phase II	Soil samples are taken from the ground and then analyzed for potential hazardous material as determined by the local EPA.							
Soil borings	Soil borings will determine the compressive strength of the soil and rock as well as soil composition and depth of rock. This is used to determine the bearing capacity of the base foundation material.							
Test pits	Test pits are dug prior to utility installation to determine if there are any obstructions prohibiting the path of utilities. Test pits will allow for safe digging to ensure that no other utilities will be compromised during the excavation process. It also gives an indication of the type of soil up to four feet below the surface.							

Table . Exhibit 3-3 Required testing.

2. Soils								
Type	Soil types can vary in strength. Rock is the strongest. Weathered rock has less capacity, sand even less, and clay has the lowest compressive strength.							
Compressive strength	Compressive strength gives the soil a value as to how much weight the soil can take without deflection.							
Expansive clay	Expansive clay has the ability to expand when fully saturated. This can shift a structure sitting on it.							
Settlement	All soil types are expected to settle over time after the building is erected. The soil must be tested to understand how much settlement is to be expected.							
Settlement monitoring Shear	Check the condition of a building and monitor the settlement of the structure. Shear is the soil's ability to want to cave into an open end.							
Compaction	Soil is tested for proper density as required.							

3. Foundation								
Pile loads	Test piles, which are sample building piles, are driven in various locations throughout the site. Weights are then brought in and applied to these piles. The piles are measured for any settlement or movement to ensure that they are capable of supporting the required loads.							
Piling driving criteria	Dropping of the pile hammer must conform to the standards established.							
Shoring and underpinning	When special construction is required to temporary support sections of an existing structure, then the existing sections being supported must be monitored for any stress or movement.							

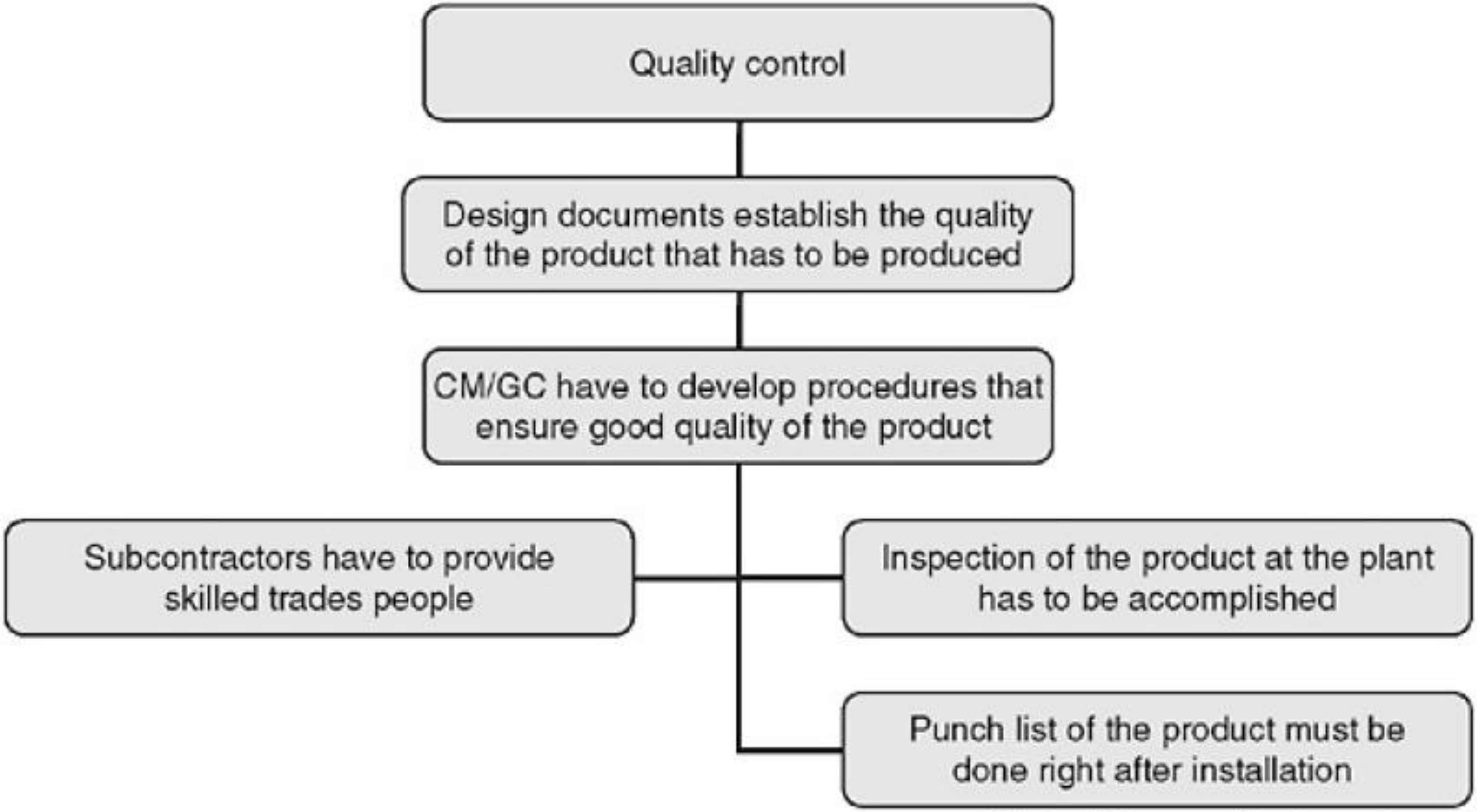


Figure . Exhibit 3-4 Quality control flowchart.

Quality Assurance

"All the planned and systematic activities implemented within the quality system and demonstrated as needed, to provide adequate confidence that an entity will fulfill requirements for quality."

Quality Audit

- A systematic and independent examination to determine whether quality activities and related results comply with planned arrangements and are implemented effectively and are suitable to achieve objectives.
- Quality audit is necessary to simulate and maintain unending improvement in team performance and product quality.
- Quality audits may be scheduled or random, and they may be carried out by properly trained in-house auditors or by registered third parties such as quality system agencies.

Total Quality Management

TQM

- concept was evolved in Japan after World War II.
  - need to compete in the global market where higher quality, lower cost, and more rapid development are essential
- . Today: TQM :
  - fundamental requirement
  - It is a way of planning, organizing, and understanding each activity of the process and <u>removing all the unnecessary steps</u> routinely followed in the organization.

Periodical Changes in Quality System

Period	System
• Middle Ages (1200–1799)	• Guilds-skilled craftsman were responsible to control their own products.
• Mid-18th century • Industrial Revolution	• Establishment of factories. Increase in productivity. Mass production. Assembly lines. Several workers were responsible for producing a product. Production by skilled workers and quality audit by inspectors.
• Early 19th century	• Craftsmanship model of production.
• Late 19th century • 1880s	• Fredrick Taylor and "Scientific Management." Quality management through inspection.
• Beginning of 20th century • 1920s	• Walter Shewhart introduced Statistical Process Control. Introduction of full-time quality inspection and quality control department. Quality management.
• 1930s	• Introduction of sampling method.
• 1950s	• Introduction of Statistical Quality Process in Japan.
• Late 1960s	• Introduction of QA.
• 1970s	• Total Quality Control. • Quality Management.
• 1980s	• TQM.
• Beginning of 21st century	• Integrated Quality Management (IQM).

Changing Views of Quality

Past	Present
• Quality is the responsibility of blue-collar workers and direct labor employees working on the floor.	• Quality is everyone's responsibility, including that of white-collar workers, the indirect labor force, and the overhead staff.
• Quality defects should be hidden from customers (and possibly management).	• Defects should be highlighted and brought to the surface for corrective action.
• Quality problems lead to blame, faulty justification, and excuses.	• Quality problems lead to cooperative solutions.
• Corrections to quality problems should be accomplished with minimum documentation.	• Documentation is essential for "lessons learned" so that mistakes are not repeated.
• Increased quality will increase project costs.	• Improved quality saves money and increases business.
• Quality is internally focused.	• Quality is customer focused.
• Quality will not occur without close supervision of people.	• People want to produce quality products.
• Quality occurs during project execution.	• Quality occurs at project initiation and must be planned for within the project.

Cultural Changes Required to Meet TQM

From	To
• Inspection orientation	• Defect prevention
• Meet the specification	• Continuous improvement
• Get the product out	• Customer satisfaction
• Individual input	• Cooperative efforts
• Sequential engineering	• Team approach
• Quality control department	• Organizational involvement
• Departmental responsibility	• Management commitment
• Short-term objective	• Long-term vision
• People as cost burden	• Human resources as an asset
• Purchase of products or services on price-alone basis	• Purchase on total cost minimization basis
• Minimum cost suppliers	• Mutual beneficial supplier relationship

Principles of Total Quality Management

- Customer satisfaction.
- · Management leadership to create quality culture.
- · Improvement of processes.
- · Education and training on job skill and TQM tools.
- · Defect prevention in lieu of inspection.
- · Use of data and statistical tools.
- · Developing a team approach.
- · Aiming at continuous improvement.