# Acceptance Sampling

applied by the U.S. military to the testing of bullets during World War II. If every bullet was tested in advance, no bullets would be left to ship. If, on the other hand, none were tested, malfunctions might occur in the field of battle, with potentially disastrous results.

# Acceptance Sampling


***Definition of Lot Acceptance Sampling***

- a sample should be picked at random from the lot, and on the basis of information that is yielded by the sample, a decision should be made regarding the disposition of the lot.
- In general, the decision is either to accept or reject the lot. This process is called *Lot Acceptance Sampling* or just *Acceptance Sampling*.

- Acceptance sampling is "the middle of the road" approach between no inspection and 100% inspection.
- There are two major classifications of acceptance plans: by *attributes* ("go, no-go") and by *variables*.
- main purpose of acceptance sampling is to decide whether or not the lot is likely to be acceptable, not to estimate the quality of the lot.

***Scenarios leading to acceptance sampling***

- Testing is destructive
- The cost of 100% inspection is very high
- 100% inspection takes too long

# 1. Single sampling plans

- One sample of items is selected at random from a lot and the disposition of the lot is determined from the resulting information.
- These plans are usually denoted as $(n, c)$ plans for a sample size $n$, where the lot is rejected if there are more than $c$ defectives.
- *These are the most common (and easiest) plans to use although not the most efficient in terms of average number of samples needed.*

# Double sampling plans

- After the first sample is tested, there are three possibilities:
  - Accept the lot
  - Reject the lot
  - No decision
- If the outcome is (3), and a second sample is taken, the procedure is to combine the results of both samples and make a final decision based on that information.

  - If $d_1 <= a_1$, the lot is accepted.
    If $d_1 >= r_1$, the lot is rejected.
    If $a_1 < d_1 < r_1$, a second sample is taken.

  - If a second sample of size $n_2$ is taken, the number of defectives, $d_2$, is counted. The total number of defectives is $D_2 = d_1 + d_2$. Now this is compared to the acceptance number $a_2$ and the rejection number $r_2$ of sample 2. In double sampling, $r_2 = a_2 + 1$ to ensure a decision on the sample. If $D_2 <= a_2$, the lot is accepted.
    If $D_2 >= r_2$, the lot is rejected.

# Sequential sampling plans

*Comparisons*

- . This is the ultimate extension of multiple sampling where items are selected from a lot one at a time and

*Sequential plan :-------*

- after inspection of each item a decision is made to accept or reject the lot or select another unit.

*Comparisons*

*Sequential plan :-------*

| $n$ inspect | $n$ accept | $n$ reject |
|---|---|---|
| 49 | 1 | 3 |
| 58 | 1 | 4 |
| 74 | 2 | 4 |
| 83 | 2 | 5 |
| 100 | 3 | 5 |
| 109 | 3 | 6 |

The corresponding single sampling plan is (52,2) and double sampling plan is (21,0), (21,1).

# PROJECT QUALITY MANAGEMENT

# INTRODUCTION

- During the last 100 years, the concept of product quality management has dramatically changed from the inspection-only scenario to the Total Quality Management (TQM).

- In the early part of the 20th Century, the focus on quality was on inspection of the end product.

- Gradually, it moved to the production process control using **statistical quality control techniques** followed with **acceptance sampling** of the end products.

# Quality in project management

- the quality of the project product (construction facility)

  *planning, assurance, control, inspection and performance audit.*

- the quality of the project management processes

# QUALITY CONCEPT

viewed from different angles such as ;

1. customer's requirement,
2. fitness for use,
3. conformance to standards,
4. degree of craftsmanship,
5. zero-defect product,
6. organization's brand / credibility and so on.

# Quality at every phase!!

- the quality must be built into construction from the early stages of the project development.

- **An error in the design stage** will have more impact on quality than, say a rework on defect rectification during construction.
  - For example, a design discrepancy in an RCC beam design, if noticed during pre-concreting stage will cost for redesigning and work stoppage,
  - if observed after concreting will cost for dismantling and recasting,
  - and if it cracks after the building is occupied then the cost of rectification will include cost of user's vacation / inconvenience, and cost of rework of all the affected structural components.

# QUALITY MANAGEMENT PRINCIPLES

- Quality is **crucial for business survival**.
- Quality direction is top-down with commitment at all levels in the organization.
- Quality of the product should be **right the very first time**, aim is zero-defect.
- **Quality assurance must be built into the system** so as to ensure adherence to specified standards.
- Quality control implies **zero-defect performance** standard.
- **85% of the defects occur due to process** malfunctioning and 15% are attributable to people.
- Quality improvement is a **continuing process**.
- Quality is measured by the cost incurred on the non-conformance.
- Quality process is controlled by facts/data derived from the time tested quality tools.

# Benefits of Quality

- Enhanced Customer Satisfaction
- Reduction in costs incurred towards poor quality
- Increased awareness of quality amongst employees towards achievement of stipulated objectives
- Increased communication

## The quality requirements in construction projects differ in many ways from the manufacturing industry.

- Construction projects are unique
- difficulty in defining construction quality standards,
- difficulty in verifying quality standards which cannot be easily measured with instruments,
- type and form of building contract,
- variable geographical and geological conditions,
- illiterate and unorganized manpower,
- one time people relationships,
- stakeholders' conflict,
- lack of experience of client.

# Quality -related Processes

- Quality planning
  - quality assurance,
    - quality control
      - inspection,
      - quality audit.

# Quality Planning

- The quality planning involves
  - identifying the quality standards that are relevant to the project and
  - determining how to ensure conformance to these standards.
    ( Quality assurance)

- **Quality management plan** describes as to how to achieve the quality objectives.
  - organizational structure, responsibilities,
  - Work procedures,
  - processes,
  - benchmarking,
  - material testing facilities,
  - quality checklist

# Quality Control and Inspection

Quality control involves

" monitoring output of specific stages in the production to determine if they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory results."

# Checklists

**Project Name**

**Consultant Name**

**QUALITY CONTROL OF FORMWORK / FALSEWORK / DIMENSIONS / LEVELS**

CONTRACTOR: DATE : / /

CONTRACT NO:

Site Engineer : ______________________________

Inspected Element : ______________________________

(N.B.: This form is to be prepared by the Site Engineer and submitted to the R.E.)

(A=Acceptable, N=Needs Adjustment, U=Unsatisfactory)

**1) Form Dimensions & Levels :**

| | | A | N | U |
|---|---|---|---|---|
| 1.1 | Setting Out | | | |
| 1.2 | Top of Concrete Level Ready for Casting | | | |
| 1.3 | Dimensions | | | |
| 1.4 | Heights & Levels | | | |
| 1.5 | Chamfers | | | |



**2) Falsework :**

| | | A | N | U |
|---|---|---|---|---|
| 2.1 | Supports | | | |
| 2.2 | Rigidity | | | |
| 2.3 | Bracing | | | |
| 2.4 | Screw Jacks | | | |
| 2.5 | Timber Straightness | | | |
| 2.6 | Splices of Vertical Members | | | |

**3) Formwork :**

| | | A | N | U |
|---|---|---|---|---|
| 3.1 | Rigidity | | | |
| 3.2 | Water Tightness | | | |
| 3.3 | Steel Bolts / Rods / Ties | | | |
| 3.4 | Openings & Inserts | | | |
| 3.5 | Cleanliness | | | |
| 3.6 | Oiling | | | |
| 3.7 | Working Platforms and Walkways | | | |

**R.E's Comments :**

______________________________

______________________________

______________________________

______________________________

Signature of Resident Engineer ______________________ Date : ____________

**Project Name**
**Consultant Name**

# CHECKLIST FOR CONCRETE CASTING

CONTRACTOR: ____________________

CONTRACT NO: ____________________ Date : __/__/__

Building / Structure : ____________________

Element : ____________________

| No. | Description | Status | |
|---|---|---|---|
| | | Availability | Detail |
| | **PLANT & TOOLS** | | |
| 1 | Concrete Pumps | | |
| 2 | Standby Concrete Pumps | | |
| 3 | Cranes | | |
| 4 | Truck Mixers | | |
| 5 | Vibrators | | |
| 6 | Trowlers | | |
| 7 | Lighting | | |
| 8 | Access Means | | |
| 9 | Communications | | |
| | **QUALITY CONTROL** | | |
| 1 | Cubes | | |
| 2 | Slump Apparatus | | |
| 3 | Thermometer | | |
| | **STAFF & LABOUR** | | |
| 1 | Engineer | | |
| 2 | Foreman | | |
| 3 | Carpenter | | |
| 4 | Steel Fixer | | |
| 5 | Electrician | | |
| 6 | Mechanic | | |
| 7 | Vibrating Labour | | |
| 8 | Trowling Labour | | |
| 9 | Ordinary Labour | | |



SITE ENGINEER

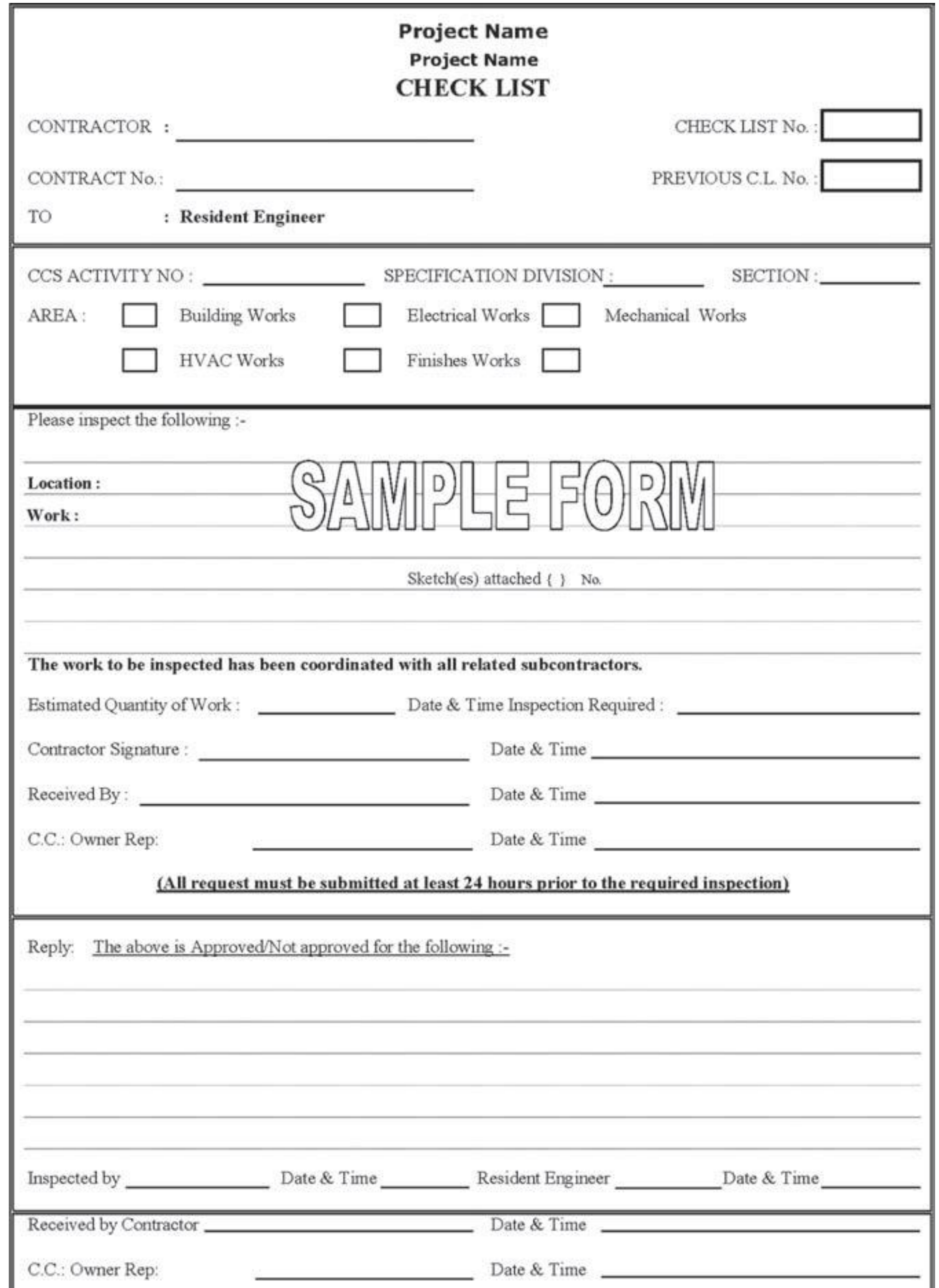
CONTRACTOR MANAGER

CONSULTANT RECEIVED: ____________________ DATE: __/__/__ TIME: ________

COMMENTS:

**Signature of Resident Engineer:** ____________________ **Date:** ____________

- Checklist for general works to be inspected.



**Project Name**
**Project Name**
**CHECK LIST**

CONTRACTOR : ____________ CHECK LIST No. : [ ]

CONTRACT No.: ____________ PREVIOUS C.L. No. : [ ]

TO : **Resident Engineer**

CCS ACTIVITY NO : ________ SPECIFICATION DIVISION : ________ SECTION : ________

AREA : [ ] Building Works [ ] Electrical Works [ ] Mechanical Works

[ ] HVAC Works [ ] Finishes Works [ ]

Please inspect the following :-

**Location :**

**Work :**

SAMPLE FORM

Sketch(es) attached ( ) No.

**The work to be inspected has been coordinated with all related subcontractors.**

Estimated Quantity of Work : ________ Date & Time Inspection Required : ________

Contractor Signature : ________ Date & Time ________

Received By : ________ Date & Time ________

C.C.: Owner Rep: ________ Date & Time ________

**(All request must be submitted at least 24 hours prior to the required inspection)**

Reply: The above is Approved/Not approved for the following :-

Inspected by ________ Date & Time ________ Resident Engineer ________ Date & Time ________

Received by Contractor ________ Date & Time ________

C.C.: Owner Rep: ________ Date & Time ________

- Remedial note

**Project Name**
**Consultant Name**

**REMEDIAL NOTE (RN)**

Contractor: ______________________________ R.N. No.: __________

Contract No.: ______________________________ DATE: __________

Your attention is drawn to the following works which have not been carried out in accordance with the Contract and are therefore not acceptable. Failure to carry out remedial works within a reasonable period of time may result either in additional work at your expense, or the Employer may elect to invoke Clause ---of the General Conditions of Contract.

LOCATION:

DEFECTS:

SAMPLE FORM

Signed: ____________ Resident Engineer Received by: ____________ Contractor/Date

Distribution: ☐ Owner ☐ A/E ☐ Contractor ☐

- Non Conformance Report

**Project Name**
**Consultant Name**

**NON-CONFORMANCE REPORT**
**NO. [ ]**

**CONTRACTOR:** **DATE :** / /

**CONTRACT NO:**

**Location of Non-Conformance :** ____________________

**Drawing / Specification :** ____________________

SAMPLE FORM

**Description of Non-Conformance :** ____________________

**Resident Engineer :** ____________________

**Corrective / Preventive Action : (Proposed by Contractor)**

**Quality Control Engineer :** ____________________

**Contractor Manager:** ____________________ **Date:** ____________________

**Comments:**

**Resident Engineer:** ____________________ **Date:** ____________________

Design Checklist: Structural Work

**Table A.2.1 Foundation Layout**

| Serial No. | Item | Yes | No | Action Required |
|---|---|---|---|---|
| 1 | Check that latest architectural drawing is used | | | |
| 2 | Check axis and grids match architectural layout | | | |
| 3 | Check location of columns axis | | | |
| 4 | Check that depth of excavation matches required depth for no. of basements | | | |
| 5 | Check for thickness of blinding concrete | | | |
| 6 | Check that waterproofing and moisture protection material is suitable for subsurface conditions | | | |
| 7 | Check that foundation design is consistent with geotechnical report/soil report | | | |
| 8 | Check footing details for foundation | | | |
| 9 | Check that seismic requirements for foundation are considered | | | |
| 10 | Check footing design | | | |
| 11 | Check minimum concrete cover considered | | | |
| 12 | Check total load calculated and considered | | | |
| 13 | Check coefficient of sliding on foundation soil considered | | | |
| 14 | Check levels are shown | | | |
| 15 | Check expansion joints are shown | | | |
| 16 | Check reinforcement details are shown | | | |
| 17 | Check spacing arrangement for reinforcement | | | |
| 18 | Check foundation for pits, tanks considered | | | |
| 19 | Check for type of concrete and steel | | | |
| 20 | Check for earthquake, seismic control requirements | | | |

**Table A.2.2 Basement Design (Continued)**

| Serial No. | Item | Yes | No | Action Required |
|---|---|---|---|---|
| **d) Basement: Slab** | | | | |
| 1 | Check that latest architectural drawing is used | | | |
| 2 | Check that axis and grids match architectural layout | | | |
| 3 | Check total load and load factor | | | |
| 4 | Check span length matches architectural requirements | | | |
| 5 | Check type of slab per design requirements | | | |
| 6 | Check that moment and other forces are considered | | | |
| 7 | Check steel area | | | |
| 8 | Check minimum concrete cover area | | | |
| 9 | Check openings are considered for services requirement | | | |
| 10 | Check for deflection | | | |
| 11 | Check if slope is required | | | |
| 12 | Check provision for floor drains for drainage, sanitary system | | | |
| 13 | Check that levels are shown | | | |
| 14 | Check that expansion joints are shown | | | |
| 15 | Check authorities requirements for fire protection | | | |