Chapter 6: Measurement of Precipitation – Recording and Non-Recording Types

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Introduction

Precipitation is one of the most fundamental hydrologic variables and serves as the primary source of water for any hydrological system. Its accurate measurement is crucial for water resource planning, flood forecasting, design of hydraulic structures, and agricultural water management. Civil engineers rely heavily on precipitation data to assess rainfall patterns, estimate runoff, and predict water availability. This chapter focuses on the methods and instruments used to measure precipitation, categorizing them into recording and non-recording types.

6.1 Characteristics of Precipitation Measurement

Before diving into instrumentation, it is important to understand what parameters need to be measured:

- **Intensity** (mm/hr)
- **Duration** (minutes or hours)
- **Frequency** (return period)
- **Amount** (total precipitation over a time)
- **Spatial Distribution**

The type of instrument used depends on whether these parameters are to be observed continuously (recording) or occasionally (non-recording).

6.2 Non-Recording Rain Gauges

Non-recording rain gauges are simple devices that collect rainfall over a specific period. They do not provide information on the time distribution or intensity of rainfall.

6.2.1 Symons Rain Gauge (Standard Non-Recording Type)

The Symons rain gauge is the standard non-recording gauge adopted by the Indian Meteorological Department (IMD).

Components:

- **Cylindrical collector** (outer metallic container)

- **Receiver** (funnel and collecting bottle)
- **Measuring jar** (graduated in mm)

Installation:

- The gauge is mounted on a concrete base with the rim at 30 cm above ground level.
- It must be placed in an open space, away from buildings or trees.

Procedure:

- Rainwater is collected in the bottle.
- The collected water is measured daily at 8:30 AM using the graduated measuring cylinder.

6.2.2 Limitations of Non-Recording Gauges

- Cannot record the intensity or time variation of rainfall.
- Manual observation required; prone to human error.
- Not suitable for remote or automated monitoring systems.

6.3 Recording Rain Gauges

Recording rain gauges automatically record rainfall as it occurs, providing a continuous graphical or digital record of precipitation with respect to time.

6.3.1 Weighing Bucket Rain Gauge

This type measures the weight of accumulated precipitation.

Components:

- A bucket mounted on a weighing mechanism.
- A pen attached to the mechanism records data on a chart.

Working Principle:

- As rain falls into the bucket, its weight increases.
- The increased weight causes the pen to deflect on a time-chart, giving cumulative rainfall over time.

Advantages:

- Accurate and suitable for snow or mixed precipitation.
- Provides cumulative as well as intensity data.

6.3.2 Tipping Bucket Rain Gauge

One of the most commonly used automatic gauges, especially in remote weather stations.

Components:

- A funnel leads rain into a small double-bucket system.
- Each bucket tips when filled with a fixed volume (e.g., 0.25 mm).
- A magnetic switch records each tip electronically.

Working Principle:

- Each tip corresponds to a known volume of rainfall.
- A data logger records the number and timing of tips.

Advantages:

- Suitable for digital recording and remote sensing.
- Good resolution for high-intensity rainfall.

Limitations:

- Less accurate in snowfall or very low-intensity rain.
- Can underestimate rainfall due to water loss during tipping.

6.3.3 Float Recording Rain Gauge

Used in older meteorological setups.

Components:

- A float chamber that rises with collected rainfall.
- A pen linked to the float traces the rainfall on a rotating chart.

Working Principle:

- The float rises as the water level increases.
- The pen moves over a time-chart, producing a mass curve of rainfall.

6.4 Modern Electronic and Digital Rain Gauges

Modern technologies use digital sensors and telemetry for real-time rainfall monitoring.

6.4.1 Optical Rain Gauges

- Use laser or infrared beams.
- Detect drops passing through beam and estimate size/intensity.
- Non-intrusive and maintenance-free.

6.4.2 Acoustic and Radar Rain Gauges

- Use Doppler and radar techniques to estimate precipitation over a wide area.
- Common in advanced meteorological radars and weather forecasting systems.

6.5 Selection of Rain Gauges

The selection of a rain gauge depends on:

- **Purpose** (research, operational, rural/urban usage)
- **Budget** and **automation needs**
- **Climatic conditions** (snowy, tropical, coastal)
- **Topography** and **accessibility**

6.6 Gauge Network and Density

The reliability of rainfall data also depends on the density and distribution of gauges.

Recommended Density by WMO (World Meteorological Organization):

- **Flat regions**: 1 station per 500–1000 sq. km.
- **Hilly regions**: 1 station per 100–250 sq. km.
- **Urban areas**: 1 station per 10–20 sq. km.

IMD in India follows similar standards but adapts them based on terrain and data availability.

6.7 Common Errors in Precipitation Measurement

1. **Instrumental Errors**:
    - Faulty calibration.
    - Overflow or evaporation loss.
2. **Observation Errors**:

  - Misreading by observer.
  - Recording delay or forgetfulness.

3. **Siting Errors**:
   - Improper placement.
   - Obstructions (buildings, trees).

4. **Wind Errors**:
   - Wind-induced turbulence reduces effective catch.

Windshields and aerodynamic corrections are used to minimize these effects.

6.8 Maintenance and Calibration

Regular maintenance ensures accuracy:

- Cleaning funnel and orifice.
- Checking for leaks or blockage.
- Calibration against known volumes.
- Chart and clock synchronization (in analog types).

6.9 Data Presentation

Rainfall data from gauges is presented in formats like:

- **Mass Curves** (cumulative rainfall vs. time)
- **Hyetographs** (rainfall intensity vs. time)
- **Double Mass Curves** (used for consistency checks)
