Techno India NJR Institute of Technology

(Approved by AICTE, New Delhi and Affiliated to Rajasthan Technical University Kota (Raj.))

Lab manual

Water Resources Engineering Design Lab

Semester: V   Year: III (2023-24)

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RAJASTHAN TECHNICAL UNIVERSITY, KOTA
Syllabus
3rd Year - V Semester: B.Tech. (Civil Engineering)

5CE4-23: WATER RESOURCES ENGINEERING DESIGN LAB

Credit: 1	**Max. Marks: 100(IA:60, ETE:40)**
0L+0T+2P	**End Term Exam: 2 Hours**

Design as per syllabus of theory.

EXPERIMENT NO. - 1

Name of the the experiment: Non – recording rain gauge

Apparatus required: - funnel, Metal casing, glass bottle.

Theory: - Non recording rain gauge collects the rain water and is measured by means of graduated cylinder and volume of rainfall is recorded and depth of water is calculated by formula.

Volume of water collected in cm3 / area of aperture of the gauge in cm2 = cm depth of water.

Procedure:-When the rainfalls, it is collected in the bottle. A man comes daily daily at 8:30 AM
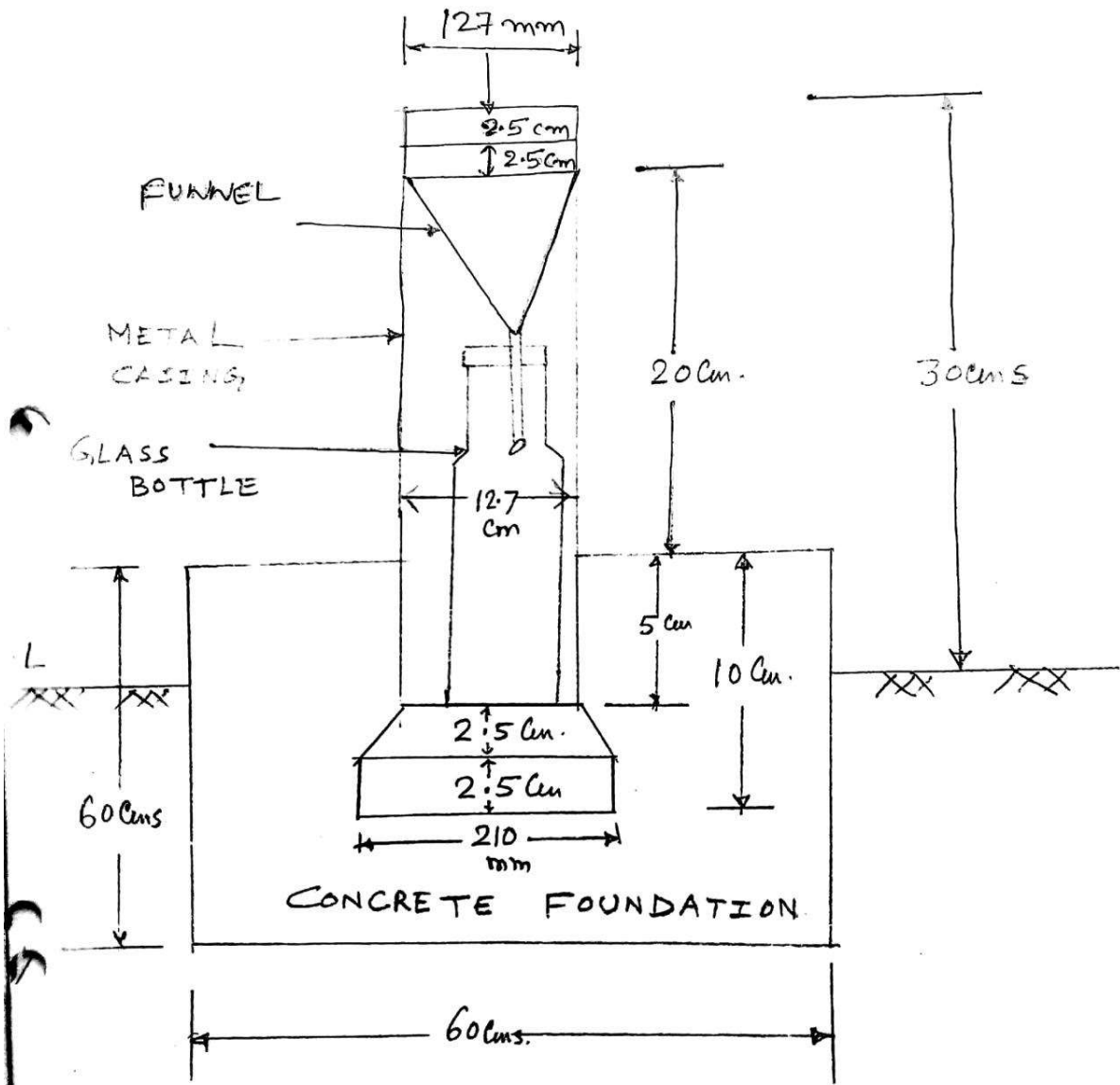
(InIndia) and measures and records the rainfall collected in the bottle by pouring it in to a standard

Graduated measuring jar (Two different types of jars for 200 cm2 and 100 cm2 collectors are available).

This process of measuring at 8:30 AM and recording the rainfall of the past 24 hour's .is common throughout this country

However , if the rainfall on a the certain day is too much ,and is likely to exceed the capacity of the bottle ,then two or three intermediate readings may be taken and their sum will then have to be recorded as the rainfall of the past 24hrs,of the day . On which the final reading (i.e., at 8:30 AM) istaken. When the rainfall on a given day exceeds 2.5mm, then that day is called a rainyday.

127 mm

2.5 cm

2.5 Cm

FUNNEL

METAL CASING

GLASS BOTTLE

12.7 Cm

20 Cm.

30 cms

5 Cm

10 Cm.

L

60 Cms

2.5 Cm.

2.5 Cm

210 mm

CONCRETE FOUNDATION

60 cms.

NON- RECORDING RAIN GUAGE

EXPERIMENT NO.-2

Name of experiment: measurement of rain fall by recording rain gauge, Tipping bucket type

Apparatus required – Funnel, Measuring glass, cover

Theory – The rainwater inters the circular collector and then passes through a funnel. The funnel discharge the water into two compartment buckets. When 0.25 mm water gets filled in one compartment, the bucket tips up, emptying in to a reservoir, and moving the second compartment into place beneath the funnel. The tipping of the bucket completes and electric circuit, causing a pen to mark on revolving drum .Since the movement of the tipping of the bucket can be transmitted electrically over distances, such gauges are generally installed in hilly area and in accessible areas from where they can supply their measurements directly to the control room at meteorological station.

Procedure- The tipping bucket type rain gauge consists of 30 cm diameter sharp edge receiver ,at end of the receiver funnel is provided .A pair of bucket are pivoted under the funnel such a way that when one bucket receives 0.25mmof precipitation it tips discharging its content into a reservoir bringing the other bucket under the funnel .

|←——— 30 Cm ———→|

RAIN
WATER

CIRCUCAR
COLLECTOR

FUNNEL

TWO COMPARTMENT
TIPPING BUCKET

RESERVOIR
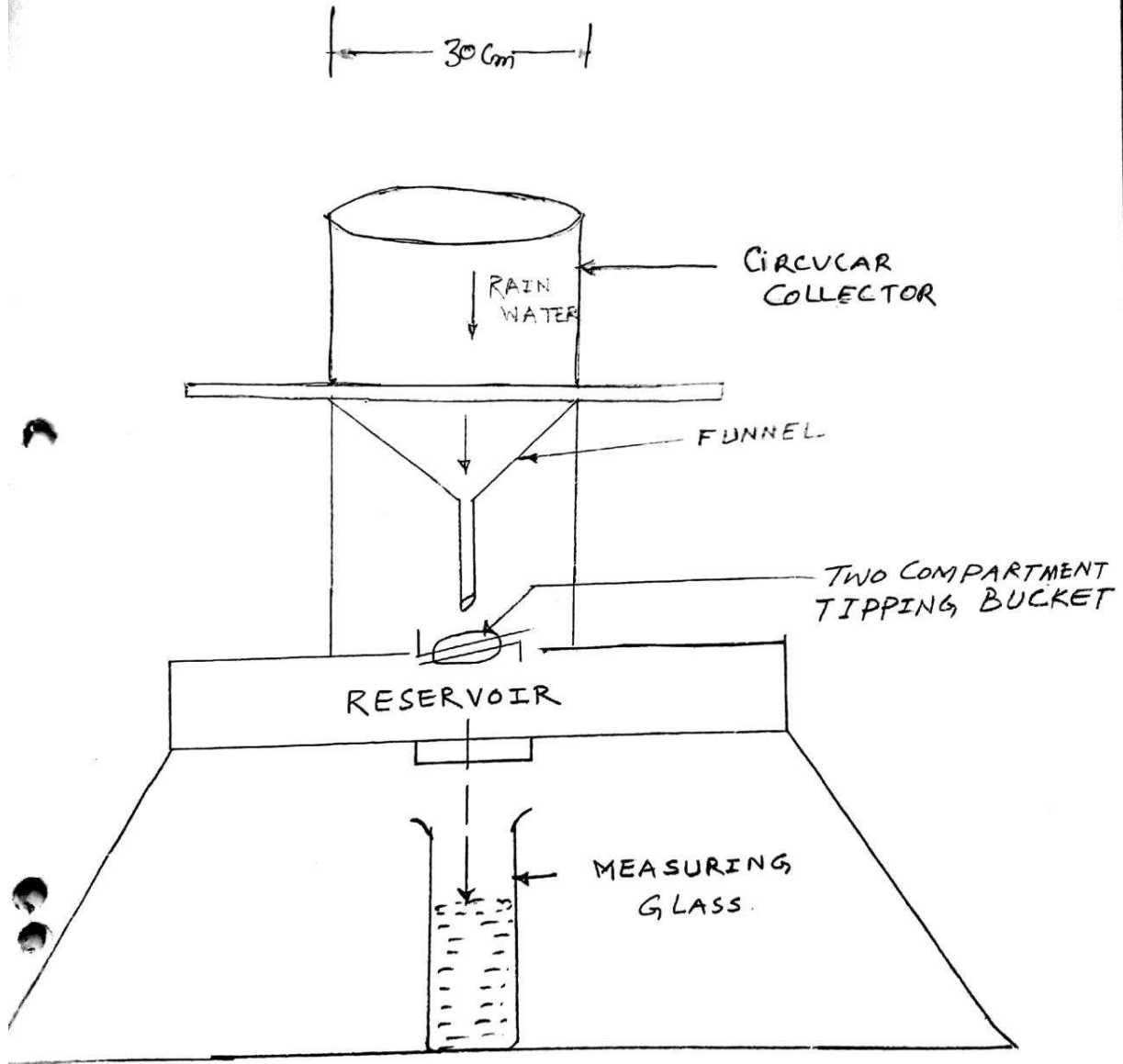
MEASURING
GLASS.

Name of the experiment:-Thiessen polygon method

Apparatus required: 1) Rainfall recording instrument at station

2) Station marking instrument

3) Measuring take

Theory –Adjacent station are joined by straight lines thus dividing the entire

area in series of triangles ,perpendicular bisectors are erected on each of these

lines ,thus forming a series of polygons each containing one and only one rainfall stations .if P is mean rain fall and area of basin is A then

P = (A1P1+P2+A3P3+……….An Pn)/A

Where P1,P2,P3…. Represents rainfall at respective station and A2, A2, A3….

Are the area surrounding polygons.

Procedure- The area is divided into triangles .the various. Stations namely 1,2,3,4… are joined then divided the area into triangles by joining shorter diagonal two and four then draw perpendicular bisector by dotted lines to divide the area into polygons .then rainfall P is calculated .

① MID POINT 1 & 2

A1

A2

② MID POINT 2 & 3

MID POINT 4 & 1

A4

A3

③

④ MID POINT 3 & 4
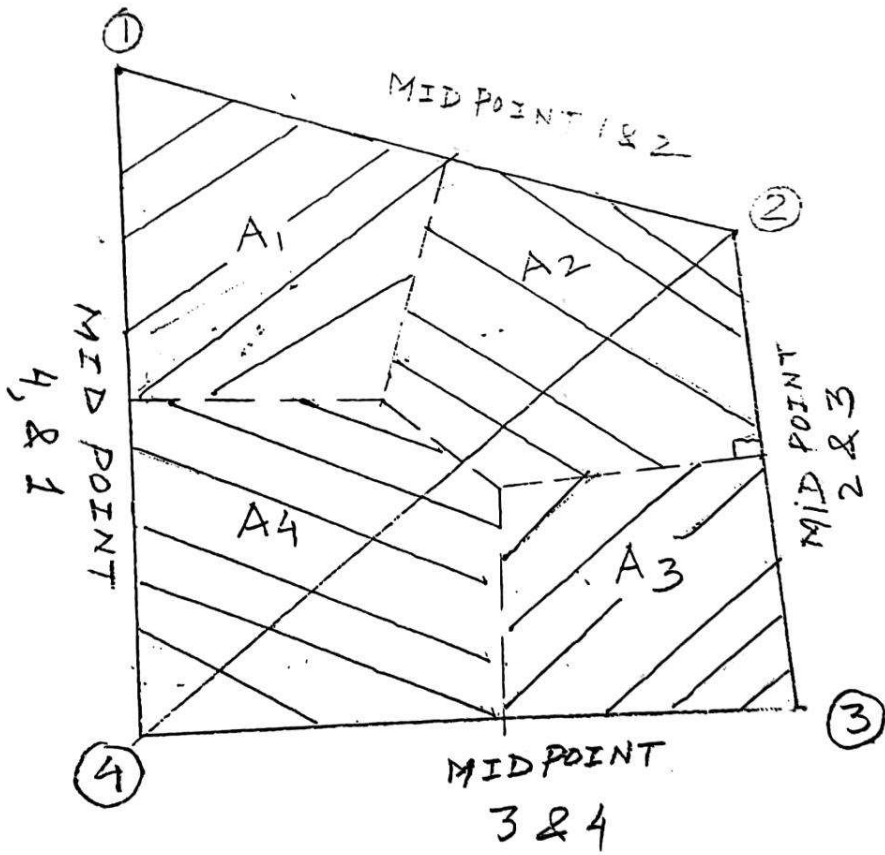
EXPERIMENT NO.4

Name of the experiment: Average rainfall by Isohyetal method

Apparatus required : 1.Rainfall recording instrument at station

2. Station marking instrument

3. Measuring tape

4.planimeter

Theory: - Isohyetal are contours of equal rainfall. They are drawn on map after the rainfall at each station is plotted .the area between the adjacent Isohyetal in each station is calculated as below .

Pav = $\dfrac{A1(p1+p2)/2 + A2(p2+p3)/2 + A3(p3+p4)/2 + \ldots+\ldots.An(pn\text{-}1 + pn)/2}{A1+A2+A3\ldots\ldots\ldots\ldots+An}$

Where pav = Mean precipitation.

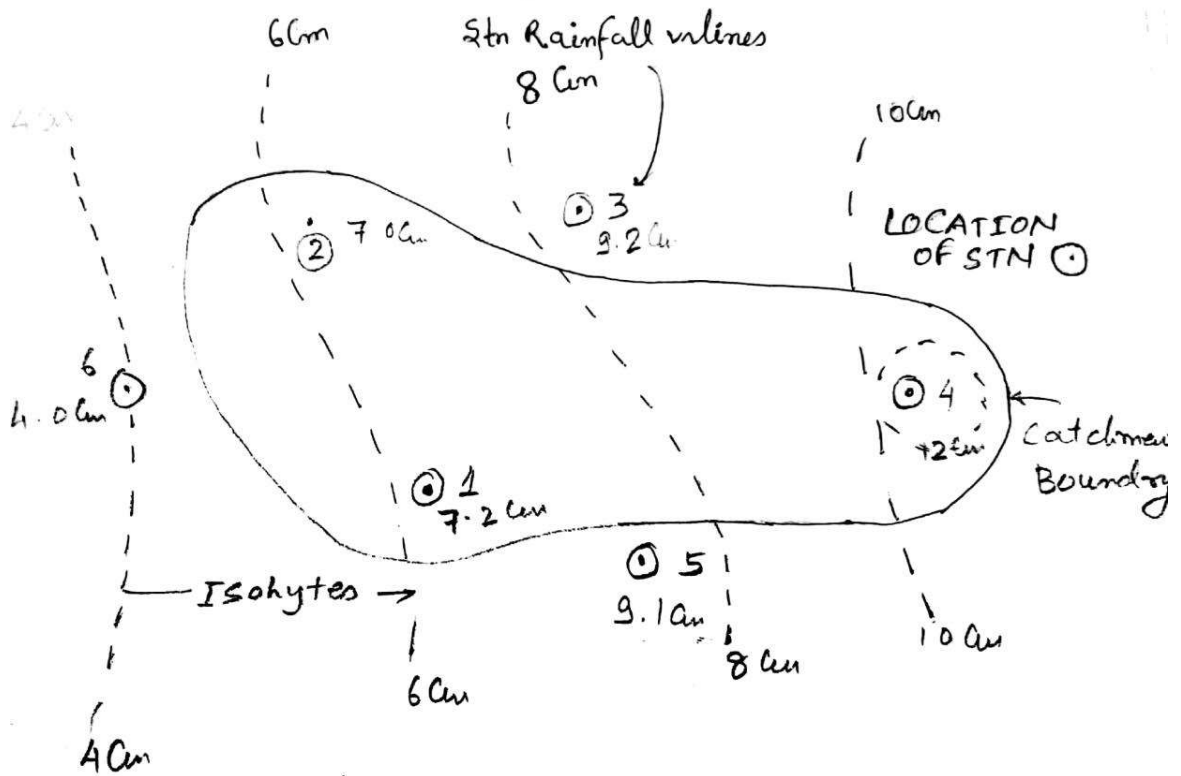P1,P2,P3,……. Are precipitation at station 1,2,3…….,&A1,A2,A3, are catchment area measured by plannimeter ,

Procedure:

1. For measuring the mean precipitation ,the area A1,A2,A3,……An is calculated by plannimeter .
2. Then rainfall values are recorded as raingauge station & Isohyetal maps are prepared .
3. Multiply the area with rainfall of each isohyets and then .

4. Pav = $\dfrac{A1(p1+p2)/2 + A2(p2+p3)/2 + A3(p3+p4)/2 + \ldots+\ldots.An(pn\text{-}1 + pn)/2}{A1+A2+A3\ldots\ldots\ldots\ldots+An}$

Thus mean rainfall is calculated.

WRE
EXP NO, 4

Stn Rainfall vnlines

6 Cm

8 Cm

10 Cm

4 Cm

○ 3
9.2 Cm

LOCATION
OF STN ○

② 7 0 Cm

6
4.0 Cm ○

○ 4
+2 Cm

Catchment
Boundary

○ 1
7.2 Cm

← Isohytes →

○ 5
9.1 Cm

8 Cm

10 Cm

6 Cm

4 Cm

EXPERIMENT NO. 05

Name of the experiment: To determine velocity and discharge of water using current meter

Apparatus required: current meter, instrument for measuring cross sectional area of flow of water in river, stream on canal

Theory: stream water velocity is typically measured using a current meter, generally consists of propeller or a horizontal wheel with a small core shaped cups attached to it which fill with water and turn the wheel when placed in flowing water .the number of rotating of the propeller or wheel cap mechanism corresponding with velocities at the water flowing in the stream water subjected ton friction from stream bed and air. Thus when we take water velocities measurement it is conventional to measure flow at 0.6 times the total depth, which typically represents the average flow velocity in the stream.

Procedure : This is achieved by attaching the current meter to a height calibrated rod ,the rod can also be used to measure stream stage height .the discharge can be found by multiplying the velocity to the cross sectional area of the flow .

EXPERIMENT NO. 6

Aim: To find the manning's coefficient (n)

Apparatus: Rectangular channel, measuring tank Hook etc.

Theory : When water flow in open channel ,resistance is offered to it ,when result in causing a head loss due to resistance and also result is loss of energy .The resistance is in countered by the flowing water is generally counteracted by the component of gravitational force acting on the body of the water in the direction of the motion for establishment of uniform flow in open channel, the resistance to the flow must be balanced by the gravity force .the fundamental equation for uniform flow is an open channel may be divided by applying newton's second law of motion .and is known as manning's coefficient .

Manning's formula

V= 1/n R 2/3 S ½

When

 n=manning's Rugousity coefficient

r= hydraulic mean depth =A/P

s= Slope of channel =y/L

Procedure:-

 Water is let out in the rectangular channel by opening the valve of supply pipe .when the flow becomes stable and uniform, the observations are taken to find out n .The depth of flow is measured by the noting the reading of the hook gauge when it touches the bed of the channel and free surface of the water discharge is measured by noting the volume of water collected in the tank for certain period of time and manning rugosity coefficient is calculated with the help of formula

Name of the Experiment: Design a regime channel by Lacey theory for the given pattern of crops and area to be irrigated

Apparatus required: Regime channel, leveling instrument, tape

Theory:

Velocity $V=(Qf^2/140)^{(1/6)}$

Where V= velocity in m/s

Q= Discharge m3/s

F= silt factor

F= 1.76*sqrt(d mm)

A= Q/V

P= 4.75*sqrt(Q)

$A=BD+D^2/2$

$R=5V^2/(2f)$

Where A =area of cross section

P= perimeter

Side slope is ½:1

$R=(BD+D^2/2)/(B+2.3D)$

$S=f^{5/3}/2240*Q^{1/6}$

$Q=$discharge in m3/s

Procedure –For designing an irrigation channel, longitudinal section and cross section

Of the channel is plotted .the FSL is to be fixed above ground level.

choose the bed slope close to lackey's slope .Also provide falls if slope available in the ground is steeper than one to be given by canal bed .the balancing depth of section is also taken .
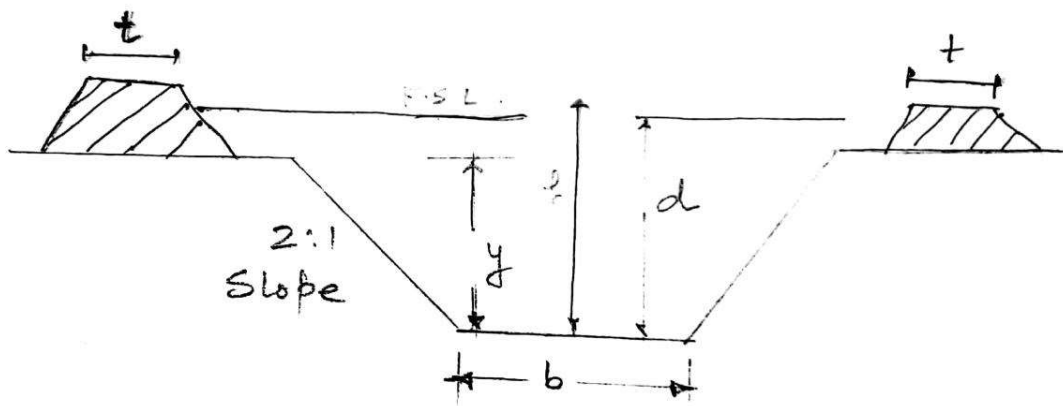
CANAL SECTION IN CUTTING.

EXPERIMENT NO. 08

Name of the experiment: Recuperation - test

Objective: To determine yield of an open well by Recuperation test

Principle: Through the constant level pumping test gives an accurate value of safe yield of an open well, it is sometimes very difficult to regulate the pump in such a way that constant level is maintained in the well. In such a circumstance, a recuperation test is resorted to. In the recuperation test, water is depressed to any level below the normal and the pumping is stopped. The time taken for the water to recuperate to the normal level is noted. From the data ,the water to recuperate to normal level is noted from the data the discharge from the well can be calculated as under .
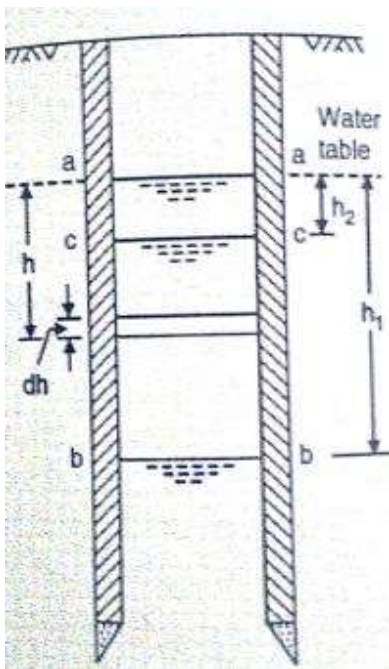
Let a_a =static water level in the well, before the pumping started.

b_b = Water level in the well when the pumping stopped

h1= depression head in the well when the pumping stopped

c_c = water level in the well at a time T after the pumping stopped

h2 = depression head in the well at a time T after the pumping stopped

h = = depression head in the well at a time t after the pumping stopped

dh = decrease in depression head in a time dt

t,T = time in hours.

Thus , in a time t, reckoned from the instant of stopping the pump ,the water level recuperate ,by (h1-h) meters in a time dt after this ,the head recuperates by a value of meters.

Where A = cross-sectional area of well at its bottom

Again, if Q is the rate of discharge in the well at the time t, under the depression head h, the volume of water entering the well in them t hours is given by

dV = Q dt

But Q is proportional to h

Or Q = Kh ….(2)

dV = K h dt …..(3)

Where K is a constant depending upon the soil at the base of the well through which water enters.

Equating (1) and (3), we get

K h dt = -A dh

The minus sign indicates that h decreases as time t increases. Integrating the above between the limits: t = 0 when h = h1 ; t = T when h = h2 .

We get $\dfrac{K}{A} \displaystyle\int_0^T dt = -\displaystyle\int_{h1}^{h2} \dfrac{dh}{h}$

Or $\dfrac{K}{A} \displaystyle\int_0^T dt = -\displaystyle\int_{h2}^{h1} \dfrac{dh}{h}$

From which $\dfrac{K}{A}T = \left[log_e h\right]_{h2}^{h1}$

$\dfrac{K}{A} = \dfrac{1}{T}log_e\dfrac{h1}{h2} = \dfrac{2.303}{T}log_{10}\dfrac{h1}{h2}$

Thus knowing the value of h1, h2 and T from recuperation test, the quality K/A can be calculated. K/A is known as the specific yield or specific capacity of an open well. In cubic meter per hour per sq. meter of the area through which water per collates under one meter depression head. In the absence of the recuperation test, the following rough values of K/A specified by Marriott can be adopted.

EXPERIMENT NO. 9

Name of the experiment: Constant level pumping test.

Objective: To determine the yield of a well by constant head method.

Principle: In this test ,a pump with suitable regulation arrangement is used .the water level is depressed by an amount h(say) known as depression head .the speed of the pump is so adjusted that whatever water enters the well under depression head .is pumped out and a constant water level maintained in the well . the amount of water pumped out is measured with the help of a v-notch or any other arrangement in a given amount of time for which the pump speed was regulated to a constant value .The quantity pumped out in one hours gives the yield of the well per hour .

The formula for discharge is comic from an open well with impervious lining may be written as

$Q= AxV$

$\quad =A \times c \times h$ Cumec …………………….(i)

Where, Q = discharge in m/sec

A = Cross sectional area of flow into the well at its base ; in m2

V= Mean velocity of water per collating into the well in m/sec

C= percolation Intensity Coefficient.

This is constant of the formation around the well .Its value is greater than for coarse soil and smaller for finer soil .

The above formula can also be derived from Darcy's law as under

Type of Soil	K/A cubic mtr per sq.m Area
Clay	0.25
Fine sand	0.50
Coarse sand	1.00

Knowing the value of K/A by observation, the discharge from a well under a constant depression head h can be calculated as under.

$Q= Kx H$

$Q = (K/A) \times A \times H$

Or $Q = 2.303/T \times (\log 10\ h1/h2) \times AH$ m3/hour

It should be noted that the time in above Expression is in hours. If T is substituted in second ,Q will be in cumec: the distance Q will be the maximum yield of the well if h corresponds to the maximum depression head .

If H is the average depression head ,Q will be the average yield .

Q = K x I x A

Q = K x A x h/L

Q = K/L x A x h

Q = C x A x h……………………….(ii)

Due to the cavity formation, the area A is taken to be equal to 4/3 times the actual cross sectional area of the bottom of the well.

From the above expression, it is clear that the discharge increase with the percolation head h .

However the percolation head h cannot be increase beyond a certain critical value because otherwise, the percolation velocity will be exceeded and the soil particle will be distributed and dislodged .the critical value of h at which the velocity is critical is known as the critical depression head .normally the depression head is kept equal to 1/8of the critical head .Such a head is known as working head.

Maximum Yield or critical yield, therefore will be obtained corresponding to the critical depression head. The yield under the working head is known as the maximum safe yield for a pumping test can find the maximum safe – yield

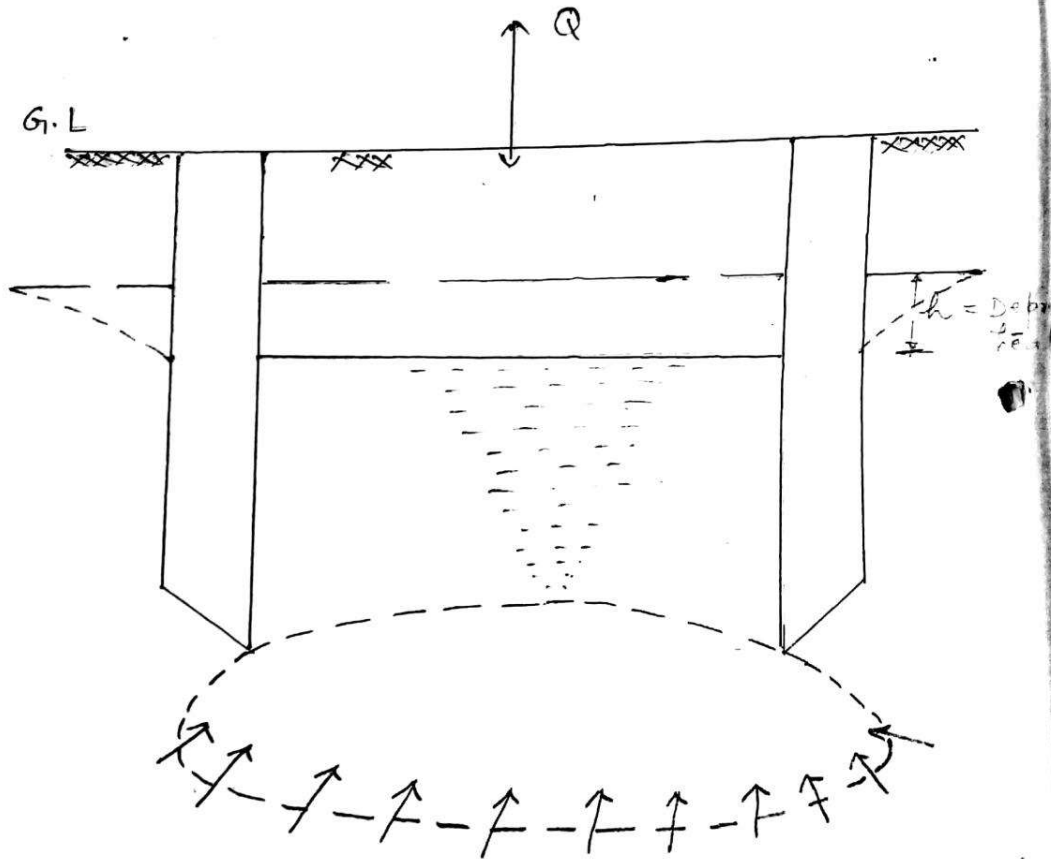Fig: Constant - level Pumping Test