06.9.15

CE-301

Environmental Engg-I

Dr. Habibur Rahman Sir

Introduction to Environmental Engg :-

- Environmental Engg –
  - Civil Engg starts from military engg.
  - who are the civil engineers.
- First two branches of engg–
  1) Military Engg
  2) Civil Engg.
- Further প্রয়োজনের তাগিদে অন্যান্য branches হয়।

- 3 types of environment are there —
  1) Soil environment
  2) Water "
  3) Air "

(*) এই তিনটি environment সার্বিকভাবে যে নামে নাম হয় সেজন্য কাজ করে environmental engg.

(*) Surrounding environment যেন polluted না হয়, সেজন্য management দরকার। সেই কাজটি করে env. engg.

e.g. Air pollute হলে কিভাবে pure H_2O পাব এবং কি করলে air pollute হবে না।

Waste water management etc.

• Before environmental engg. the following engg. subjects were there

Sanitary Engg –
mainly H_2O supply & waste disposal নিয়ে যারা কাজ করত

Public health –

• Public বলতে যাবতীয় self cleaning capacity যাবতীয়।
↓
But population বেড়ে গেলে তা আর কাজ করে না।

• Water borne disease কে prevent করা যায়।

• Different disease prevent করার জন্য এই engg. ছিল.

• env. এর নিজস্ব capacity আছে pollution remove করার জন্য
↓
This is known as
Self Cleaning Capacity

e.g. কোন well → কোন নদি/জীব মৃত অবস্থায় থাকলে অনেকে পানি দিতে বলা হয়। এই অতিরিক্ত পানি ঐ polluted পানির bacteria কে dilute করে দেয়। So clean হয়ে যায়।

Environmental Engg –
Finally comes environmental engg.

Ecology and Environment –

Climate change –
Climatic parameters – 1) temperature
2) Rainfall
3) Air flowing.

• The systemic behaviour change in these climatic parameters is climate change

•

Time Series Data ⇒ A long time period to observe/ understand time period.
e.g. 100, 200, 500 yrs etc.

• Living beings can survive in a certain climatic condition. Human being intelligent ⇒ they can survive but other low animals can't adopt ⇒ So ecological imbalance

⇓

Gradual / Slow change হলে low plants and animals slowly cope up করতে পারে।

⇓

But abrupt change হলে এই- plant / animal survive করতে পারবে না। So they will be diminished.

⇓

Imp: So the most-imp thing is that climate change should not be abrupt. We can't not stop climate change. But it should be gradual as before. The rate of accelaration of climate change should be decreased.

04.10.15

Causes of climate change –

1) Natural causes.

2) Human causes

Biodiversity

* Impact of climate change in Bd — (Table 1.1)

* Losses of Biodiversity in Bd (Not imp for xm)

Water supply —

Fig 1.8 Transmission of disease from faeces.

diseases ⇒ ↗ Communicable (ছোঁয়াচে)
↘ Non-communicable

Table 1.5

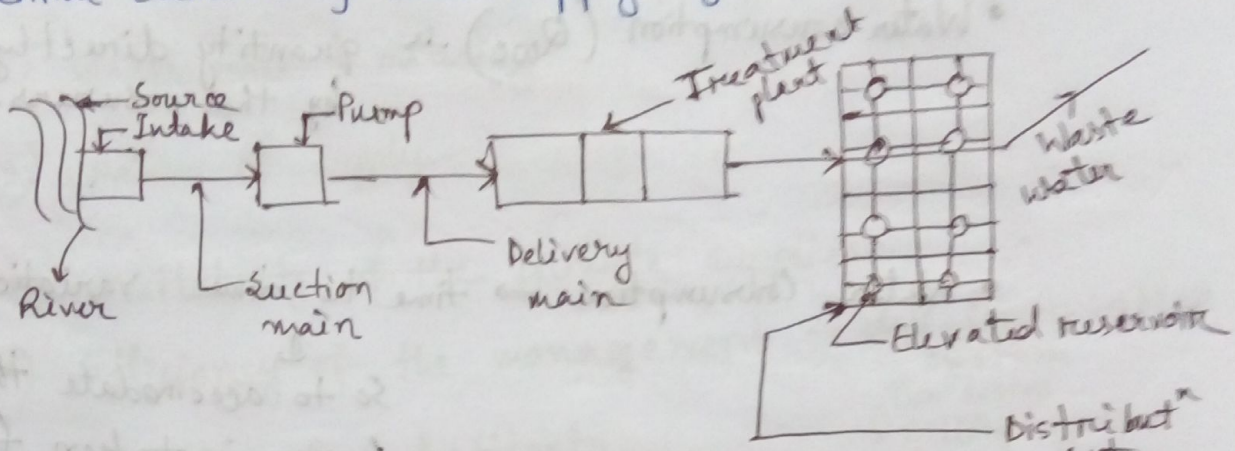
Fig 1.20 Diff. sources of H_2O.

Infiltration gallery ⇒ trench হয় / অনেকগুলি well থাকে পাশাপাশি

well ⇒ only একটি well. হয়

11.10.15

Essential elements of water supply system –



(*) 1) Source → sufficient water আছে কিনা
2) Source H_2O quality কেমন হবে যেন min^m treatment use করে required safe H_2O পাওয়া যাবে কিনা।

x chapter-1 (finished)

Chapter-3

Water Requirement

- For any water supply design–
  1) First identify the purposes of the water used

Fig: 3.1 (Flows in H_2O supply systems)

- Per Capita Consumption = $\frac{Q}{P \times 365}$ → যেকোন একটা known locality র যা জানলে similar হবে সেটাই use করা যাবে।

⇓

Per person H_2O consumption for total 1 year

যদি না থাকলে / কোন similarity না পাওয়া গেলে newly estimate করতে হবে।

- Water consumption (Q_{wc}) ⇒ quantity directly used by the consumers.

- Water Consumption ⇒ time to time variation.
  ⇅
  So to accomodate this variation 1 year is taken for the average.

- Q_d =

Factors affecting per capita consumption—

1) Size of the city
2) Characteristics of the people
3) Climate condition
4) Commerce & Industries
5) Pressure of H_2O ⇒ very imp for my country, not so imp. in developed countries
6) Quality of water
7) Sewerage facilities ⇒ যতক্ষণ পর্যন্ত pipe-এর সংযোগ থাকে ততক্ষণ পর্যন্ত required purpose-এ we ব্যবহার করবে
   ⇓
   যখনই pipe ফেটে বের হবে তখনই waste water.

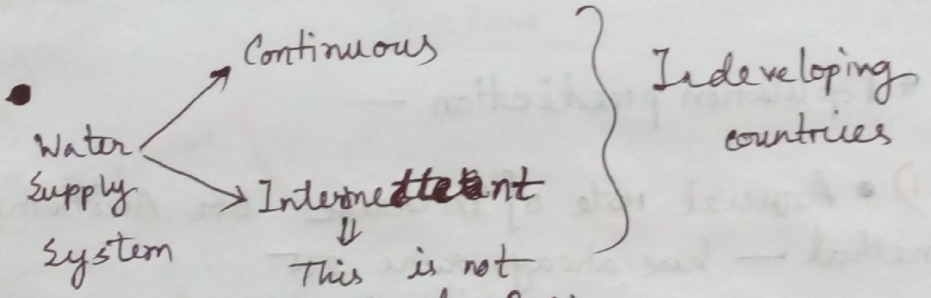
8) Water rate & metering

9) Nature of supply

10) Availability of the private supplies

11) Efficiency of the management → diff. losses in H_2O system
Two losses
1) Billing system
2) Engineering loss
বোঝা pipe → ফুটো leakage থাকলে pipe থেকে পানি পড়ে যাবে।

12) Number of inhabitants.



This is not required. Best
যে time H_2O supply থাকবে না
তখন pipe → অবশ্যই ভরে রাখে

- Water quality estimation — 2 things.
  1) For general use
  2) for fire protection

18.10.11

Fire Demand –

- Empirical formula –

1) National Board Under writter, $Q = 4637\sqrt{P}\left(1 - \frac{0.01}{\sqrt{P}}\right)$

litre per min (lpm)

P = population in thousand
i.e. if total populat^n = 10000 then, P = 10.

2) Freemand, Formula,

$Q = 1,136.5\left(\frac{P}{5} + 10\right)$

3) Kuichling Formula, $= 3182\sqrt{P}$

Population prediction —

1) • Annual rate of increase or Arithmatic progression method — base always same থাকে

2) • Geometric Progression : — base ও count করার time-এ year by year interest সহ count করতে হবে।

e.g. base = TK 10,000 at 10% interest / rate of increase

∴ After 1 year, base = 10100

3) • Incremental increase or changing rate

4) • Graphical method

Problem-1

		Increase	Incremental Increase	% increase
1940	20000	—		
1950	24500	4,500	—	22.5
1960	29500	5000	500	20.4
1970	35200	5700	700	19.3
Average increase		$\frac{4500+5000+5700}{3} = 5070$	600	20.7

• Here not yearly average/annual rate it is average (in 10 years)
⇓
per decade increase

% incremental increase
2.1
1.1
Average → 1.6

$\therefore P_{1980} = 352000 + 5070 + 600$

↓

Incremental increase method বললে এটা add করতে হবে।

⇓

Arithmatic progression বললে এটা লাগবে না।

Geometric progression method —

$$P(1+r)^n$$

$$\therefore P_{1980} = 35200\left(1+\frac{20.7}{100}\right)^{n=1}$$

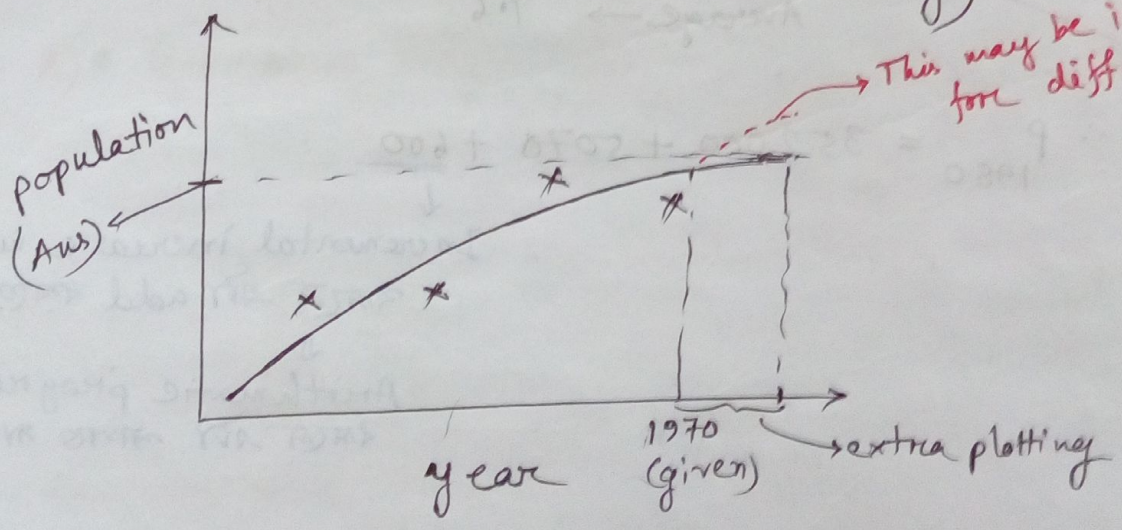
Similarly $P_{1990} = 35200\left(1+\frac{20.7}{100}\right)^{2}$

⇓

এখানে বেশি বৃদ্ধি ধরা হচ্ছে।

$$\therefore P_{1980} = 35200\left(1+\frac{20.7-1.6}{100}\right)^{n=1}$$ ⇒ যদি adjustment করতে বলে then.

- Graphical Method — (Much better but time consuming)



* but here adjustment is needed.

01.11.2015

axis হবে ⇒ যেকোন স্থান থেকে graph start করতে পারি। ⇒ but এভাবে নিলে math easy হয় (for odd no of data)

• Least square parabola :-

(x → axis, y → population)

	x	y	x^2	x^3	x^4	xy	x^2y
1970	-2	200	4	-8	16	-400	800
1980	-1	230	1	-1	1	-230	230
1990	0	280	0	0	0	0	0
2000	1	350	1	1	1	350	350
2010	2	450	4	8	16	900	1800
Σ	0	1510	10	0	34	620	3180

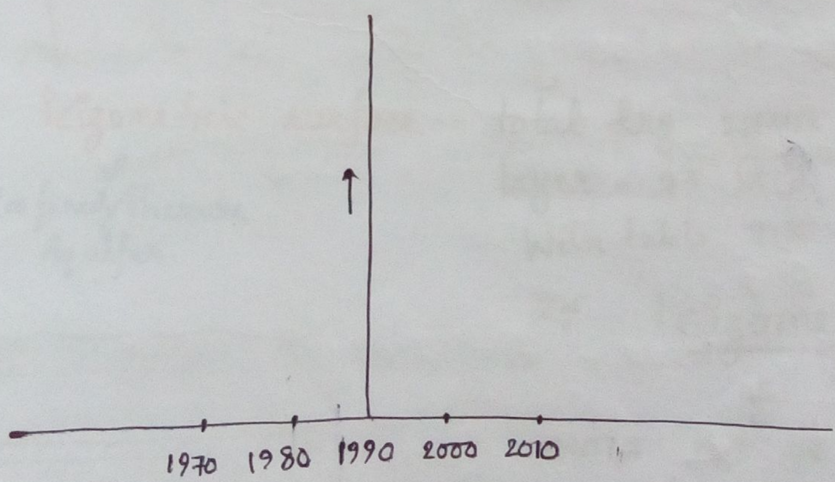
$y = a + bx + cx^2$ ⇒ (2nd order parabola)

$\Sigma y = AN + b\Sigma x + c\Sigma x^2$ ——— ① ; N = sets of data

$\Sigma xy = A\Sigma x + b\Sigma x^2 + c\Sigma x^3$ ——— ②

$\Sigma x^2 y = A\Sigma x^2 + b\Sigma x^3 + c\Sigma x^4$ ——— ③

Solving eqⁿ ①, ②, ③, we will get a, b, c.



Putting these value in eq^{n}s (1), (2) & (3)

$1510 = 5a + 0 + 10c \Rightarrow 5a + 10c = 1510$ —— (4)

~~$\therefore a = 3$~~

$620 = 0 + 10b + 0 \Rightarrow 10b = 620 \Rightarrow \underline{b = 62}$

$3180 = 10a + 0 + 34c \Rightarrow 10a + 34c = 3180$ —— (5)

$-(5) + (4) \times 2 \Rightarrow$

$10a + 20c - 10a - 34c = 3020 - 3180$

$\Rightarrow -14c = -160$

$\Rightarrow \underline{c = 11.43}$

$\therefore \underline{a = 279.14}$

$\therefore \boxed{y = 279.14 + 62x + 11.43x^2}$

Ans.

• Aquifer → Unconfined / Water table
→ Confined

(*) Steady state condition ⇒ (যখন H_2O pump করি।)

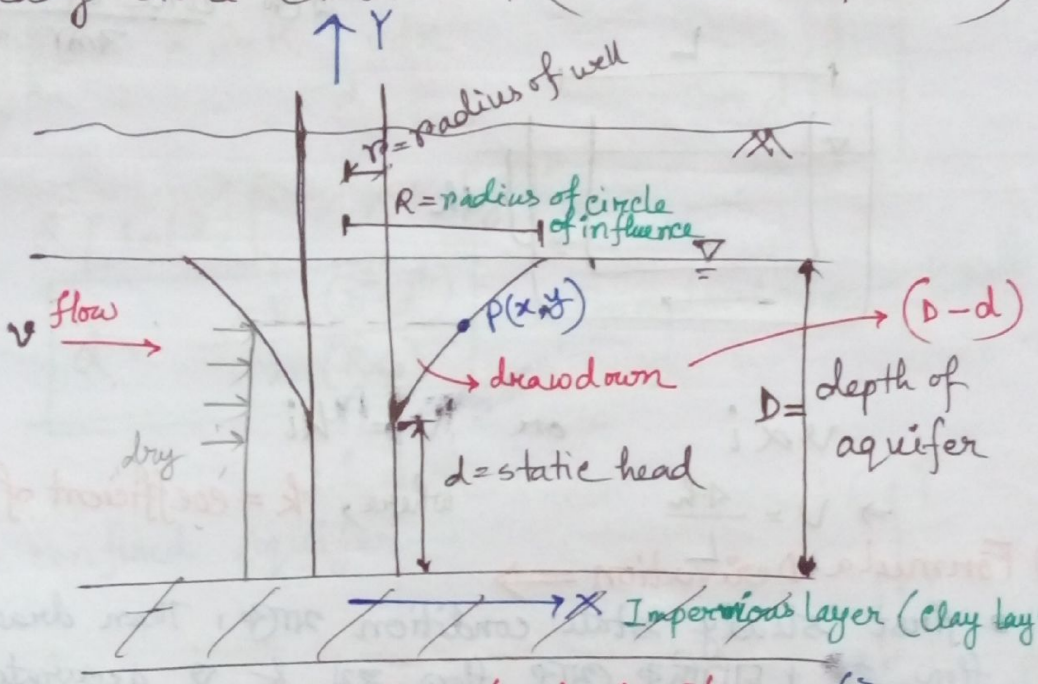


Fig Unconfined Aquifer ⇒ (উপরে কোন Imperious layer নাই)

Imperious layer

Peizometric surface – total dry করার পর Imperious layer - এর নিচে water করলে থাকে Water table বলে না, একে বলে হয় Peizometric Surface

⇓

Confined/Pressure Aquifer.

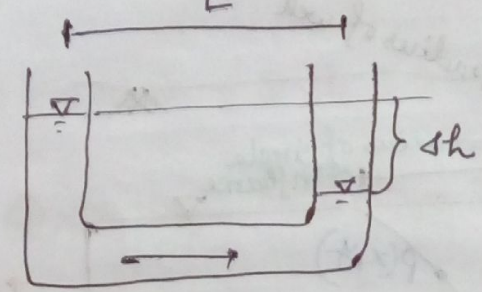
এখানে H_2O এর উপরে & নিচে i.e. aquifer - এর উভয় পাশে Imperious layer আছে।

Confined aquifer ⇐

(*) drawdown curve = $(D - d)$

↓

or Cone of depletion ⇒ এখানে cylindrical shape (3D) হয় drawdown curve, so একে cone of depletion-3 বলা হয়।



$v \propto i$ or $v = ki$

$\Rightarrow v = \frac{\Delta h}{L}$

where, k = coefficient of permeability

(*) Formula Derivation ⟹

- first steady state condition থাকে। Then drawdown হলে H_2O flow হয়। চারিদিক থেকে flow হয় & v accurately horizontal হয় না। একটু inclined হয়। So the 3 assumptions—

Assumptions

1. Steady state condition of flow.
2. Rate of velocity of flow is constant.
3. Direction of flow horizontal.

Now, $Q = Av$.

At point P, area, $A = 2\pi xy$ (area of cylinder)

$v = ki = K\frac{dy}{dx}$

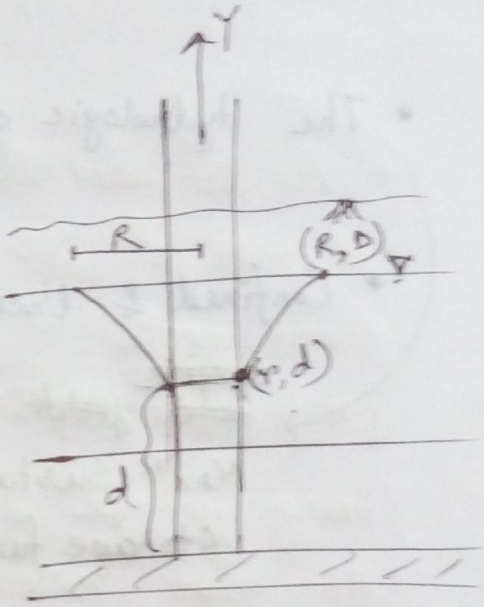
$$\therefore Q = 2\pi xyK\frac{dy}{dx}$$

$$= 2\pi Kxy\frac{dy}{dx}$$

$$\Rightarrow \int_r^R \frac{Q}{x}dx = 2\pi K\int_d^D ydx$$

or, $Q[\ln(x)]_r^R = \pi K[y^2]_d^D$

$$\therefore \boxed{Q = \frac{\pi K(D^2-d^2)}{\ln(R/r)}}$$ ⇒ Formula derive



- For confined Aquifer—

$Q = Av$

Again, $v = ki$

$= K\frac{dy}{dx}$

Now, $A = 2\pi xm$

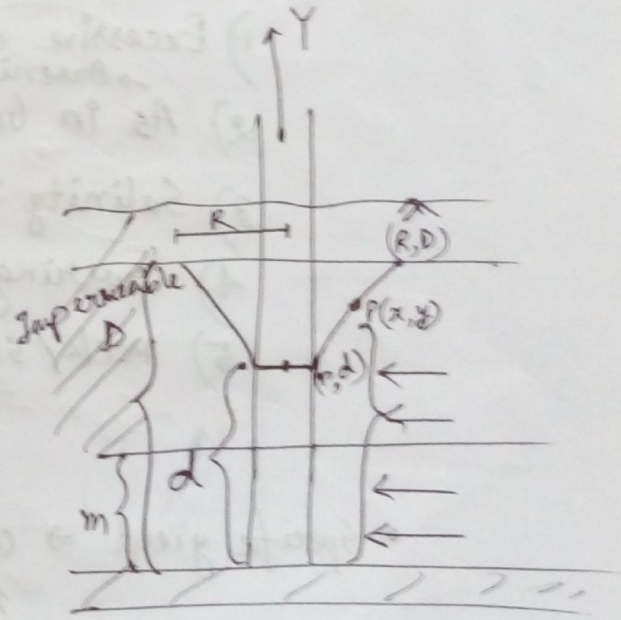
$\therefore Q = 2\pi xmK\frac{dy}{dx}$

or, $Q = 2\pi Kmx\frac{dy}{dx}$

or, $\int_r^R \frac{Q}{x}.dx = 2\pi Km\int_d^D dy$

or, $Q[\ln x]_r^R = 2\pi Km[y]_d^D$

$$\therefore \boxed{Q = \frac{2\pi Km(D-d)}{\ln(R/r)}}$$



8.11.15

- The Hydrologic cycle & Water availability –

- Confined & Unconfined Aquifer –

~~Specific~~ ~~Safe~~ ~~yield~~ Safe yield.

Max^m. Sustained yield

Storage function ← porosity
                 ← Specific yield / Specific retention.

Conduit function – K

- Problems on Groundwater Development – Imp.

GW

1) Excessive dissolved Iron
2) As (→ Arsenic) in GW
3) Salinity in the coastal area
4) Lowering of GW level
5) rock / stony layer

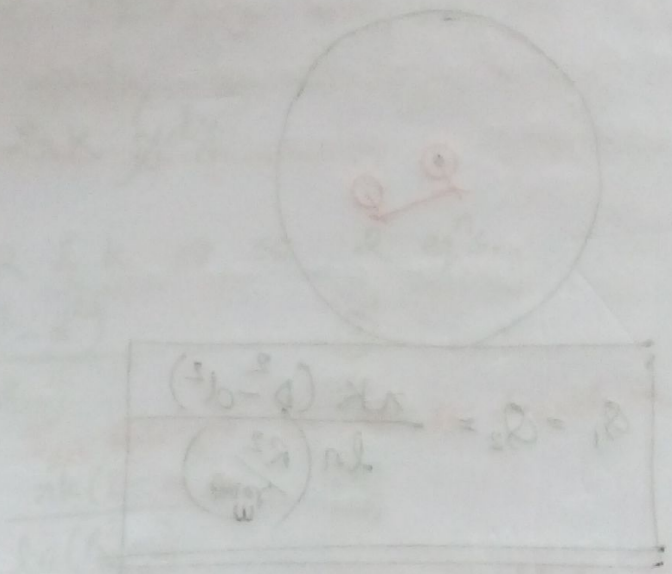
Aquiclude ⇒ যেখান থেকে H_2O বের হতে পারে না.

- Specific yield ⇒ যে পরিমাণ soil-এর porous space-এ মধ্যে থেকেও Aquifer-এ porous space যে water থাকে। but এই total amount H_2O drain out হতে পারে তাকে Specific yield.

যতটুকু drain out হতে পারে না তাই Specific retention.

CT — Population Prediction

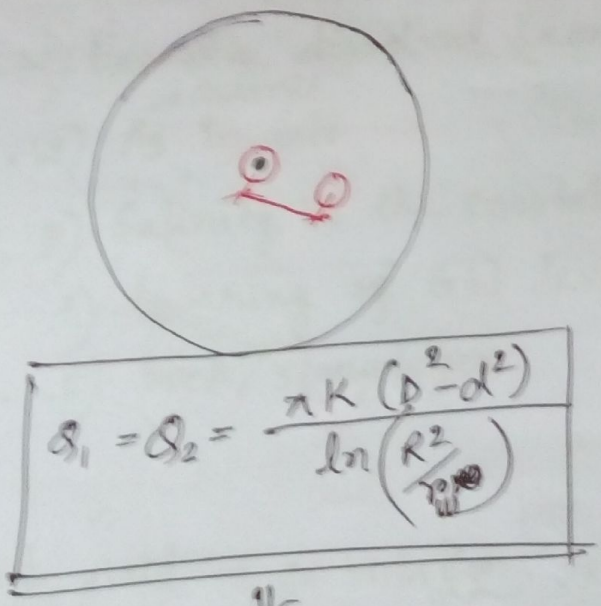
(Next Class)



15.11.15

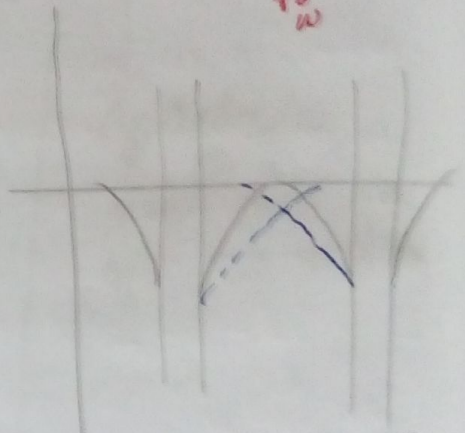
Problem

An 18" diameter ordinary well is being pumped at a rate of 350 gpm with a drawdown of 30ft. The static depth of water in the well is 200ft. During pumping the depth of water in a similar well, not being pumped at a distance of 24ft is 185 ft. At what rate could water be pumped from the two wells, if both the wells were being pumped together with a drawdown in each well of 30ft.



$$S_1 = S_2 = \frac{\pi K (D^2 - d^2)}{\ln\left(\frac{R^2}{r_w^2}\right)}$$

If two wells are in one circle of influence



Ordinary condition but circle intersect then drawdown curve is changed

New formula

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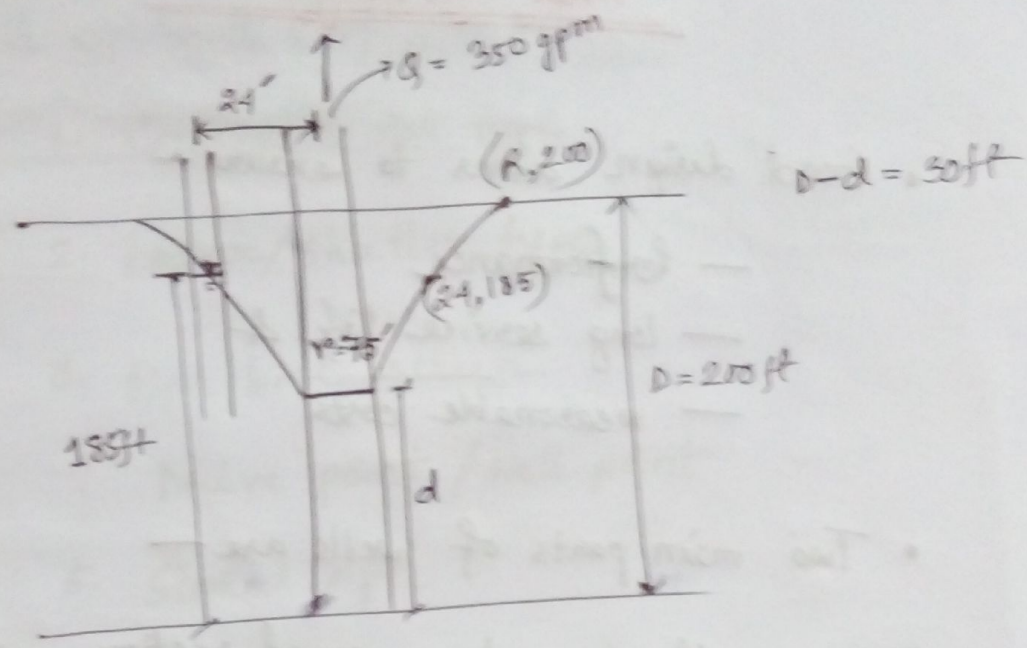
Contd



For unconfined aquifer-

$$Q \int \frac{dx}{x} = 2\pi k \int y\,dy$$

2 unknowns ⇒ R & k ⇒ so 2 eq^{n}s.

$$Q = \frac{\pi k (D^2 - d^2)}{\ln(R/r)} \quad \text{——— (2)}$$

r = 1st line-এর / 1st well-এর drawdown

& $$Q_1 = Q_2 = \frac{\pi k (D^2 - d^2)}{\ln(R^2/r_w)} \quad \text{——— (3)}$$

r_w = last line-এর drawdown / 2nd well-এর drawdown.

Now, $$Q \int_{75}^{24} \frac{dx}{x} = 2\pi k \int_{170}^{185} y\,dy$$ ⇒ Log-এর থেকে k পাব

170 ↓ d = 200-30 = 170'

Then eq^n (2) থেকে R পাব

Then eq^n (3) থেকে $Q_1 = Q_2$ হয়ে যাবে।

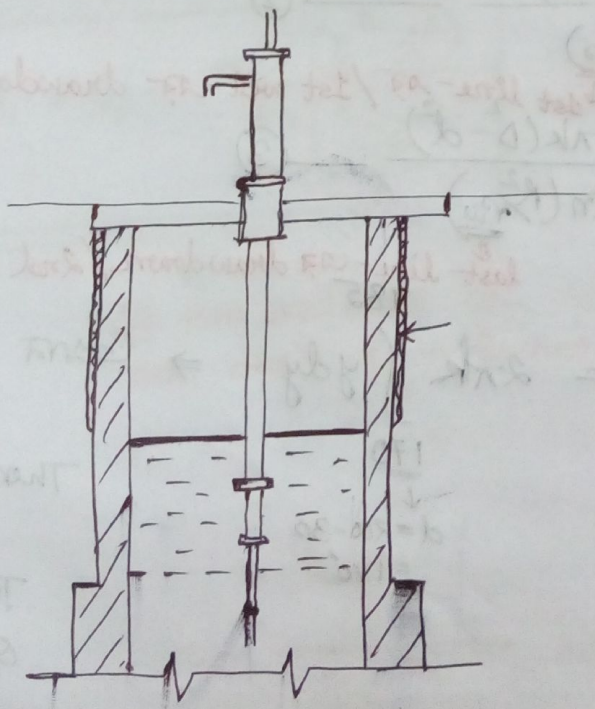
Water Well Design

- Good design aims to ensure —
  - performance
  - long service life &
  - reasonable costs

- Two main parts of wells are —

Upper parts ⇒ cased section – serves as housing pipe for pumping equipment or simply as a vertical conduit (blind pipe) through which water flows from the aquifer. ⇒ generally depends on type and size of the pump.

Lower part ⇒ intake section ⇒ Slot size



⇓

No. 10 slot has opening 0.01 inch wide

⇓

যেকোন opening এ যতগুলি slot আছে তাকে 1000 দিয়ে ভাগ দিলে যা হবে তা inch এ slot size.

• Type & construction of screen—

1. Continuous slot type
2. Louver/shutter type
3. Pipe base screen
4. Drive point / Well point
5. Slotted pipe

Mostly used:
6. Telescope size ⇒ একটা pipe এর ভিতর দিয়ে ছোট dia এরকম একটা pipe
7. Pipe size on ID size

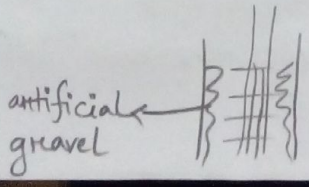
• Well screen & slot openings—

⇒ Two types—

1. Screen well ⇒ well design means screen design.
   ⇓
   এমন size screen দিব যাতে surrounding material pass না করে so that clear H_2O পাই।
   ⇓
   আবার সমস্যা screen বেশি ছোট size দিলে হয় অধিক soil particle বেশি finer হয়
   ⇓
   So less H_2O passes
2. Gravel packed well

⇒ Choice generally depends on—

1. Effective grain size (D_{50})
2. Uniformity coefficient (C_u)



This is gravel packed well ⇐ এখানে আশেপাশের soil এর চেয়ে artificially coarser soil / gravel দিয়ে দেই

Class Test ⇒ ~~Sunday~~ Saturday
Math formula + Derivation

29.11.15

- Design of well screens —

generally entrance H_2O velocity $v = 0.3$ m/sec (0.1 fps)

to protect screen against corrosion & incrustation.

- Size of gravel packed materials —

— 70% size is 4 to 6 times the 70%-size of the finest layer

— $U < 2.5$ & the smaller the better.

↳ coefficient of uniformity of the existing soil.

Thickness of gravel pack envelope = 0.75 ~ 200 mm

Slot size ≈ generally well slot is designed to retain 90% of the gravel pack materials.

↓ the material produced at lab artificially.

⇓ existing soil এর grain size dist^{n} curve বানাই

Formation Stabilization

Sanitary Protection

Upper terminal

Lower terminal of casing

Example Problem-1

Design of Tubewell

Sieve No.	Sieve size	Material retained	% Material retained	Cum. % re.	% finer
4				0	100
8				0	100
16				0	100
30		0.6	1	1	99
40		7.8	8	9	91
50		27.7	28	37	63
100		37.3	37	74	26
200		15.4	15	89	11
Pan		11.2	11.2	—	—

Grain Size Distribution Curve

⇓

from this curve 70% finer এর জন্য যে sieve size আসবে- **Slot Size**

and for this curve, $D_{50} \geq 2.5$ (approx.)

⇓

for gravel packed material, actual curve এর ন্যায় একটা curve ইচ্ছামত draw করব। Then C_u বের করে দেখব $C_u < 2.5$ হবে। So lab-এ যে material তৈরী করব তার grain size dist^n হবে এরকম।

⇐ Then এই নতুন curve এর 70% finer এর slot size

actual curve এর D_{30} এর 4 to 6 times বরাবর যে point পাব সে point দিয়ে নতুন curve আঁকব

2 Answers for screen well—

① Slot size

② Discharge

3 Answers for gravel packed well—

① Slot size

② Discharge

③ lab - এ যে soil টেষ্ট করার তার curve থাকে। But এই curve থেকে table বের করতে হবে

⇓

by back calculation

⇓

curve থেকে table বানিয়ে material টেষ্ট করলে exact পাওয়া যাবে না। So, ±8% deviation হলে No. problem

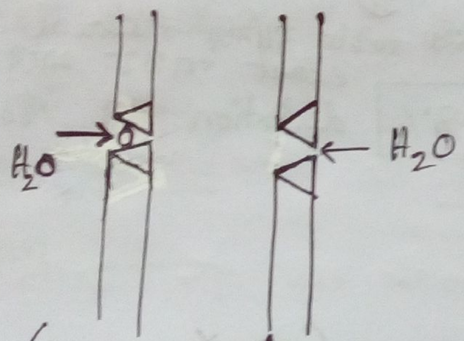
Problem-1

Sieve No.	Size	Cum. % ret.
		0–8
4	——	
8	——	
12	——	
16	——	
20	——	
30	——	
40	——	

Different types of strainers —

1. Louver type strainer
2. PVC pipe strainer
3. Continuous slot type "

sharp edge থাকে last-এ যেন মাটিতে ঢুকে যেতে & বন্ধ হয়ে যেতে পারে।



(Clogging বেশি)

(Clogging কম ⇒ cz ও material যেতে পারে না ওটা প্রথমেই আটকে যায়। So better)

- Practically well বসানোর জন্য যা করা হয় ⟹

  - for bore hole ⇒ যে location-এ coarse soil আছে & continuous, সেখানে strainer দিয়ে বসাব।

  - for location identification—
    soil analysis করতে হবে, যেখানে সবচেয়ে finer যে soil layer আছে সেটার। finer soil-এর grain size distribution curve দিয়ে well design করতে হবে।

    ⇓

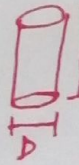
    যে স্লটার সাইজ দিয়ে fine sand যেতে পারবে না স্লটার সাইজ medium & coarse-ও যেতে পারবে না।

Table 4.1

Intake areas for selected widths of slot openings

Nominal screen size	Slot No-10	Slot No-20
	opening (areas)	opening areas

(*) In exam, opening area will be some % of solid area. Then



∴ Solid area = πDH · Then যে % x m-এ দেয়া থাকবে সে অনুযায়ী area বের করব।

↳ বলা না থাকলে 1'/unit