Book ⇒ 1) Water supply Engg. — M. A. Aziz
2) Water safety plant

01.9.2015

CE-331

Environmental Engg-I

Delwar Sir (Tuesday)

(*) সভ্যতা বলা হয় ⇒ যেখানে Water supply & sanitation ছিল
i.e. মিশরীয় সভ্যতা
মহেঞ্জোদারো সভ্যতা etc.

* Topics:

1) Pumps & pumping machinaries

2) Water distribution systems, analysis, design of distribution network

3) Water safety plans.

Imp:
* first Water treatment plan of Dhaka – 1876
* First of 18th century — Modern water treatment starts
* 1939 ⇒ This plant is redefined

* Water supply ⇒ Public health engg.
⇓
cz pure water prevents diseases & protects the health of the people.

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15.09.15

* Diseases (water borne) —

Tifoid, Diarrhoea, Pneumonia, কলেরা etc.

* Objective of water supply system —

1) To supply safe & wholesome water to cosumers
2) To supply water in adequate quantity
3) To make H_2O easily available to consumer.

Elements of H_2O supply system —

1) Source of H_2O supply — (i) ground H_2O (ii) surface H_2O.
2) Collection system — (i) intake (ii) intake main (iii) pump (iv) transmission main.
3) treatment units
4) distribution system — (i) gravity system (ii) direct pumping (iii) pumping with storage reservoir.

অঢ়লা ← (gravity system)
It is the best one
Jerusalem, Greece, Mesopotemia, Horroppa, Mohen-jo-daro,

(pumping with storage reservoir) ⇓ both gravity & direct pumping
e.g. overhead reservoir
⇓
But it is costly

Intake velocity and depths –

1) Intake entrance should lie 10' to 15' below the H_2O surface but 4' to 6' above the river bottom

2) Entrance velocity 3" to 4" per second

3) Grating or screens of 2 to 8 mesh to an inch are provided at the intake entrance

Intake pipe are designed at velocity 3' to 4' per second.

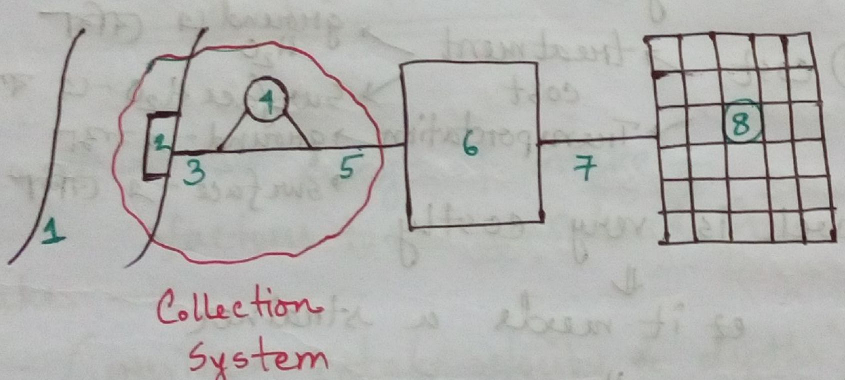

Fig: Flow diagram for H_2O supply system.

Here,
1. Source
2. Intake
3. Intake main
4. Pump
5. Transmission main
6. Treatment unit
7. Delivery main
8. Distribution system.

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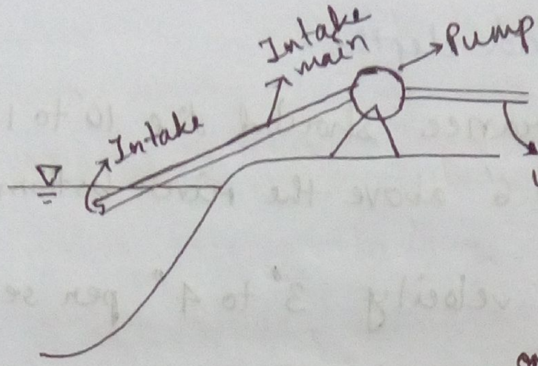


will be transmission main if it is attatched to treatment plant

⇓

or it will be delivery main if it is attatched to delivery unit.

- What will be the source will depend on three things—

1) Quantity ⇒ adequate quantity থাকতে হবে।

2) Quality

3) cost
   - treatment cost
     - ground H_2O এ বেশি
     - surface H_2O -এ কম
   - Transportation
     - ground - এ কম
     - surface - এ বেশি

⊛ tubewell is very costly

⇓

cz it needs a strainer

⇓

Then gravel ফেলতে হয়। gravel means coarser sand i.e. sand coarser than Sylhet sand

⇓

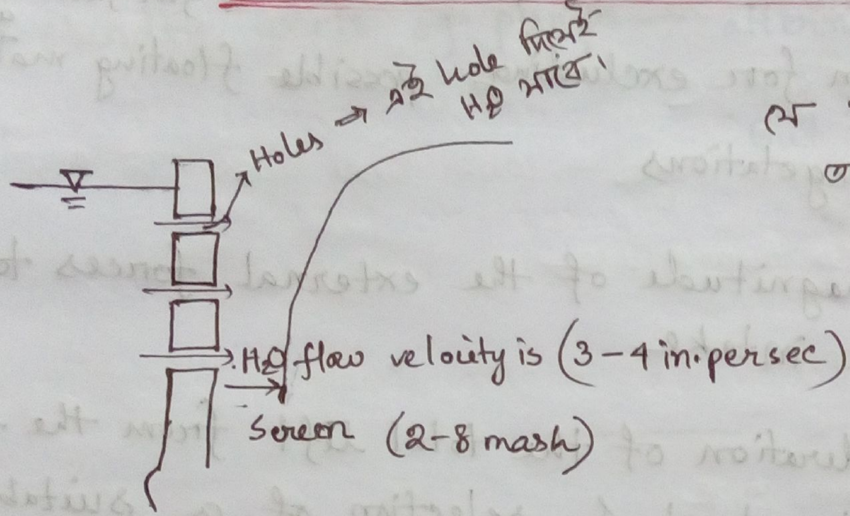
but ঠিকমত gravel ফেলতে না পারলে segregation হবে।

⇓

So বেশিদিন pump টিকবে না।

Chapter-4

Surface Water Collection & Transportation



যে Intake pipe দিয়ে H_2O যাবে তার velocity is 3-4 ft/s.

$\therefore Q = AV$
↓
3-4 ft/s.
A জানব
⇓
So Q পাব।

Fig 4.1 & 4.2 (from book).

- **Location and design of intake** —

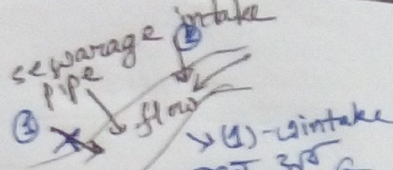
factors to be considered in locating and design of intake —

(previous Intake velocity & depths)

1) Location of the best quality of H_2O

2) Possibility of wide flatuations of H_2O level.

3) Characteristics of intake surrounding i.e. depth of H_2O, character of the river bottom, navigation, effects of waves, currents, floods and scouring the river bed & banks.



4) Formation of shoals & bars — So intake must be in (2) ⇐ এখানে ও polluted পানি পাব।

↓ মাঁছের আবাস

5) Possible sources of pollution ⇒ Water should be take from upstream & far from the polluted area.

6) Provision for excluding possible floating materials like logs & vegetations

7) The magnitude of the external forces to be resisted by the intake

8) Consideration of the total lift from the source to the treatment plant & selection of a suitable pump unit.

9) Determinatn of the total length of suction & delivery mains, head losses due to friction & small bends, enlargement & reduction.

10) Selection of suitable screen to provide around the intake

11) Installation of intake valves or port holes at 2/3 diff. levels.

12) Determination of cost benefit ratio.

13) Assurance of the safety of the intake structure.

14) Provision for future extension and installation of standby units of pumps → alternate ways থাকতে হবে যদি কোন একটা নষ্ট হয়। But কোনভাবেই H_2O supply বন্ধ যাবে না।

06.10.15

* Two types of pipes for transmission —

1. Gravity Pipe ⇒ Swarage line
2. Pressure Pipe ⇒ যেন head loss কম হয়।
   ⇓
   Water Supply line

Concrete pipe

Steel pipe

Cast iron pipe

PVC / HDPE pipe.
⇓
High Density Poly Ethylene.

* Pipes should be corrosion free ie. materials must be corrosion resistive.

* ~~Causes~~ Effects of corrosion —

1. Pitting ⇒ anode & cathode তৈরী হয়। So localized e^- pass হয় ওখানে
2. Acidity / Alkaline
3. Sulpher comopound
4. Temperature → ↑ corrosion ↑.

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5. Organic Particle (Biological Action)

6. Velocity of flow

7. Cavitation

Corrosion Control—

Scaling ⇒ hard water হলে scaling হবে।

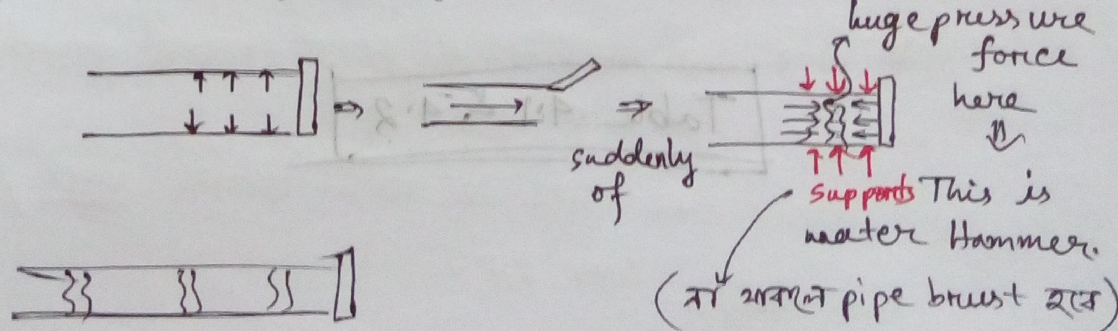
Forces acting on pipes—

1. Internal forces due to static head
2. " " " " water hammer
3. Forces at bends and changes in cross-section
4. Forces due to temperature changes
5. External forces in the form of backfill, traffic, own weights.

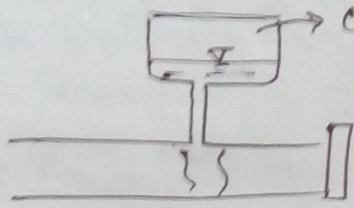
1. hoop stress ⇒ $\sigma_h = \frac{PD}{2t}$

   longitudinal " ⇒ $\sigma_L = \frac{PD}{4t}$

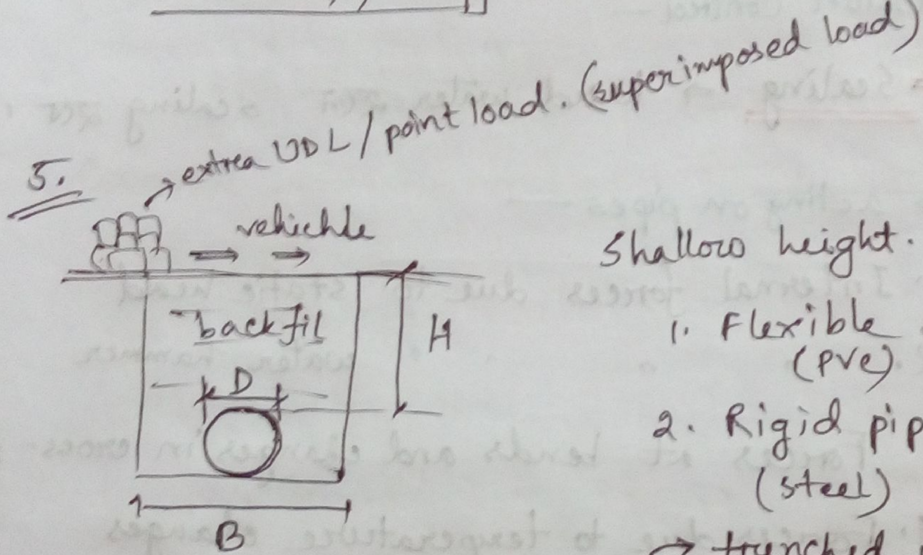
2. হঠাৎ করে flow off করে দিলে



এমন bulb আস্তে আস্তে off করতে হবে। But যদি slowly off করা না গেলে preventive measure



5.



Shallow height.

1. Flexible pipe (PVC) ⇒ load কম লাগবে
2. Rigid pipe (steel) ⇒ load বেশি লাগবে

→ trenched width কম হলে

The Pressure, $P = c\gamma B^2$ ⇒ rigid pipe

$P = c\gamma BD$ ⇒ flexible pipe

trenched width

যে স্থান কাটা হলো এই width যদি বেশি হয় then

$$P = c\gamma D^2$$

* normally trenched width dia হবে 1′–1.5′ বেশি করা হয়।

Table 4.1 & 4.2

Pipe laying -

Aziz - এর বই - Chapter 4

13.10.15

Pipe joints —

Requisites for joints — 8 points.

Pipe Laying —

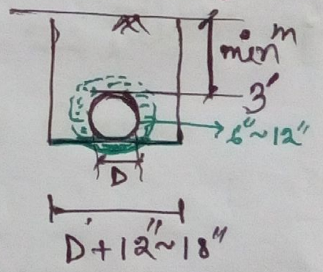
Some steps for this —

(All these type of works i.e. water lines/gas lines must be done on government land)

1) Prep. of detailed maps of roads & streets.

2) Locating the proposed alignment of the ground ⇒
- curved হলে 25'/50' পর পর trench দিবে
- straight " 100' " " " "

3) Excavating trenches. & (9) Back filling —



⇓

3' রাখা হয় যে traffic এর impact load যেন খুব বেশি না পড়ে pipe এর উপর

⊛ pipe এর চারপাশে 6"~12" cushion materials / sand দিয়ে ঢেকে দেয়া হয়।

⊛ pipe যেন নড়াচড়া না করে সেজন্য ground এ groove এর মত করা হয়।

⊛ groove যেন ভেঙে না যায় সেজন্য sand / cc layer দেয়া হয়।

6) Laying — normally slope না দিলেও হয়। but দিলে সুবিধা

8) Anchoring — cc block দিয়ে anchoring করা হয়।

10) Pipe testing — Appox. <u>70psi</u> pressure দিয়ে দেখা হয়। pipe-এ ফাটল আছে কিনা।

Class test → Chapter-4 (full)
& Chapter-1 (only location of intake)
SQ & fill in the blanks

Water Distribution System

Chapter-9

- 3 objectives —

1) to supply adequate quantity of water at adequate pressure.

⇓

pressure & supply must be equal

50–60 psi ⇒ normal supply system

100–120 psi ⇒ মাঝে মাঝে হতে পারে (special)

80–120 psi ⇒ for fire resistance ⇒ diff. line থাকে in developed countries

⇓

main H_2O supply এর পাশে parallel line থাকে high pressure এ water supply থাকে।

* normally hilly area in developed countries

⇓

এখানে water supply system create করা tough. so 200 psi পর্যন্ত দিয়ে থাকে।

⇒ শীতপ্রধান দেশে alwz tap অল্প করে খুলে রাখতে হয়। তা না হলে freezing হবে & vol^m বেড়ে যায় H_2O-এর।

2) It should be thoroughly reliable.

3) It " " economical.

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Q: Write down / Discuss the advantages or disadvantages of H_2O supply system.

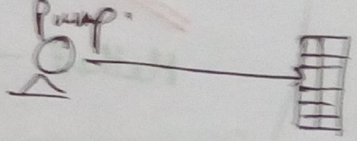
• 3 systems —

1. Gravity system
2. Direct pumping
3. Pumping with storage reservoir

Gravity system — (in Scotland) এ পাহাড়ের পাদদেশের গ্রাম / area তে

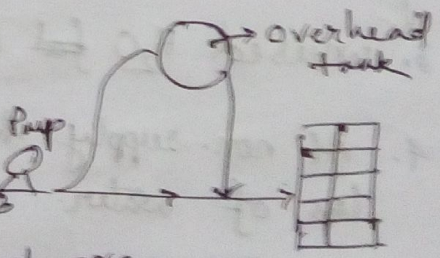
- It is economic
- It is not dependent on pump or electricity.
- No available source

Direct pumping —



- Dependent on electricity.
  pump নষ্ট হলে পানি নেই
- peak-এ যখন বেশি পানি দরকার তখন বেশি পানি পাওয়া যায় না।

Pumping



- Overhead tank-এ first-এ water তুলে রাখা হয়। So pump নষ্ট হলেও by gravity overhead tank থেকে water supply পাওয়া যাবে।
- overhead reservoir is costly & to take water to this needs huge power.

no. (3) system modify করে Underground reservoir / Roof tank use করা হয়।

- Method of H_2O supply —

1. Continuous Method
2. Intermittent ⇒ মাঝে মাঝে water supply পাওয়া যায়।
   - storage লাগবে for non-supply hours.

1. storage is economic loss ← & also a 2. greater chance of contamination.

\# Continuous ⇒ 24 hrs পানি থাকবে। At any time tap খুললেই পানি পাব।
   - storage লাগবে না।

Q. Continuous method is always better than Intermittent Method — Justify the statement.

↳ দুটো method-এর advantage & disadvantage তুলনা করে ব্যাখ্যা করতে হবে।

3. unused H_2O ~~fel~~ ফেলে দেয়। So direct wastage of water
4. At non-supply hour, the tap is being open. So direct loss of water
5. If fire breaks in non-supply hour, tremendous damage is there than continuous method.

6. Non-supply hour-এ pipe-এ vacuum হয়ে. And then creates a suction & foul gases from toilet or other areas will enter to the pipe. So contamination will be there.

But it will not happen in continuous system.

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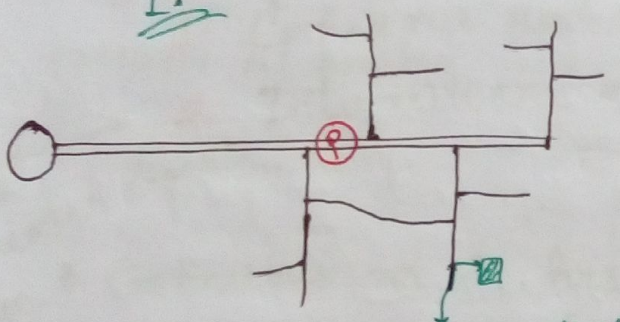
10.11.15

• Layout of water distribution system—

1. Branch or Tree or deadend system
2. Gridivon or Looped system
3. Ring or Circular system
4. Radial system

1.



always deadend থাকবে i.e. water staking থাকবে

$Q = \vec{V}A$ → generally 3–4 ft/s.

$$h_f = f \cdot \frac{L}{D} \cdot \frac{V^2}{2g}$$

এখানে থেকে eq^n দুটো solve করে dia পাব। যে dia পাব তাকে rounding করব ⇒
- 4"
- 6"
- 8"
- 10"
- 12" ⇒ এর পর 3" করে interval up to 24' - - - - .

* different pressure-এ থাকবে।

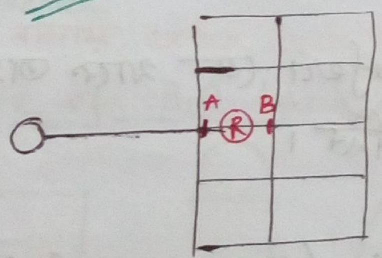
Normally 50–60 psi but not < 20 psi

disadvantages :

1. Suppose P তে repair করব & valve এখানে বন্ধ করতে হবে। So ওপর খানের বাড়িগুলিতে পানি থাকবে না।

2. Dead end -এ waste dispose হয় So dead end after 15 days clean করতে হয়। Water pressure uniform না, So এই waste water -এ মিলে water contaminate করবে।

2.



→ এর কোন dead end নাই. এখানে repair করতে চাইলে A and B তে দুটো valve দিব and off করলে অন্যদের water problem হবে না।

⇓

This is better

⇓

can be formed in planned city.

Loop System.

⇓

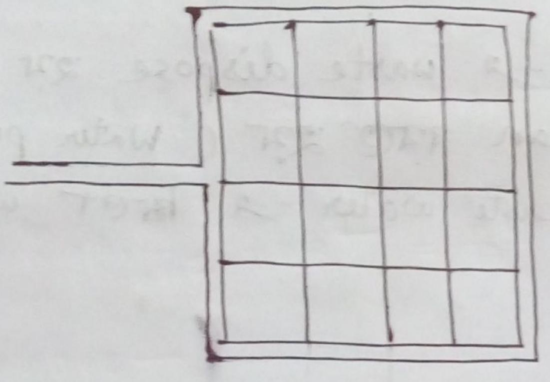
No of pipes & valves will be greater than dead end.

(is preferable)

⇓

This is analysed by hardy cross method

3.



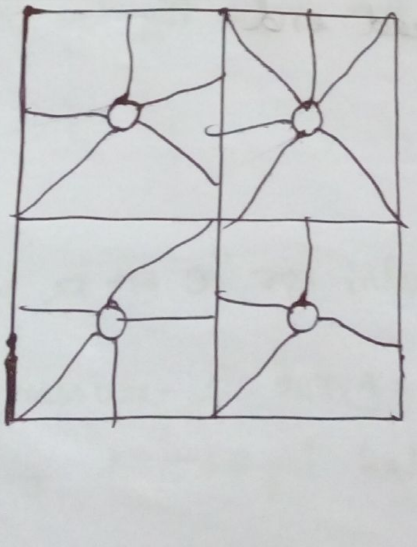
(* যদি রাস্তার width কম হয় তাহলে larger dia - এর pipe বসানো যাবে না।)

Main road যদি periferi তে থাকে তাহলে বড় dia pipe periphery তে দিব।

⇓

uniform velo. /pressure - এ water যাবে & so head loss কম হবে।

4.



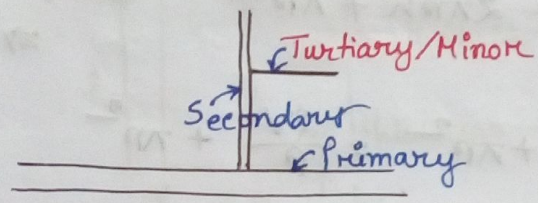
→ খুবই quick পানি চলে যাবে।

⇓

অনেক similarity with ring system

11.11.15

In water supply systems ⇒ 3 types of lines –



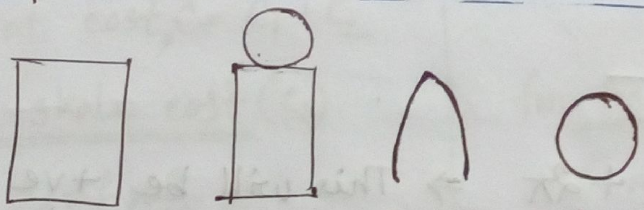
~~1gal =~~

$1\ ft^3 = 7.48\ gal$

$1\ gal = 3.785$ litre

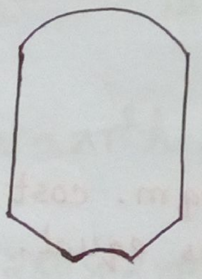
Usual Practice

- যেকোন বাসায় extra connection নিতে হলে Minor থেকে নিতে হবে।
- Shape of H_2O tank / Overhead Reservoir –



1. rectangular 2. cylindrical 3. Oval 4. Circular

5. Intze tank

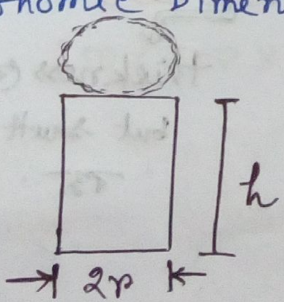


⇒ { এমনভাবে design করা হয় যেন corner effect না হয়

for Arch & Shale ⇒ rod খরচ কম so economical.

in base (bottom) ⇓ 2 sides

Economic Dimension of Cylindrical Type Water Tank –



$V = \pi r^2 h$

Lets assume, per unit cost for base & shale is same.

Area for base $= \pi r^2 = A_2$ | Vol^m = const.

" " shale $= 2\pi r h = A_1$

$\therefore A = A_1 + A_2 = 2\pi r h + \pi r^2$ — but, $V = \pi r^2 h$

$\Rightarrow h = \frac{V}{\pi r^2}$

$\Rightarrow A = 2\pi r \cdot \frac{V}{\pi r^2} + \pi r^2 = \frac{2V}{r} + \pi r^2$

first derivative —

$$\frac{dA}{dr} = -\frac{2V}{r^2} + 2\pi r = 0 \longleftarrow (1)$$

2nd derivative —

$$\frac{d^2A}{dr^2} = \frac{4V}{r^3} + 2\pi$$ $\Rightarrow$ This will be +ve for <u>min^m^</u>

from (1) $\Rightarrow$

Now, $2\pi r = \frac{2V}{r^2}$

$\Rightarrow 2\pi r = \frac{2\pi r^2 h}{r^2}$

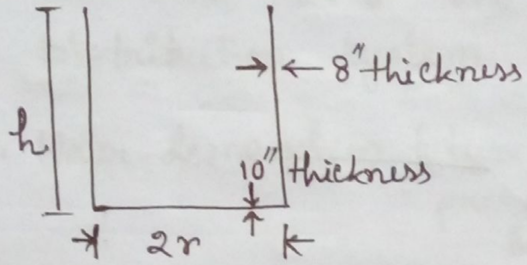
$\therefore$ $\boxed{r = h}$ $\Rightarrow$ when per sq m. cost for base & shale is equal.

But normally shale cost > base cost

shale cost ⇓ shuttering বেশি but thickness কম

base cost ⇓ thickness বেশি but shuttering কম.

- for Diff. base & Shuttering cost —



base cost = 200 TK/cft , shale cost = 250 TK/cft.

$\therefore$ Total cost, $C = C_1 + C_2$

for shale cost (C_1)

$Vol^m = 2\pi r h \times \frac{8}{12} =$

$\therefore C_1 = 2\pi r h \times \frac{8}{12} \times 250$

Now, $V = \pi r^2 h$, $h = \frac{V}{\pi r^2}$

$\therefore C_1 = 250 \times 2\pi r \times \frac{V}{\pi r^2} \times \frac{8}{12}$

for base cost (C_2)

$Vol^m \pi r^2 \times \frac{10}{12} =$

$C_2 = \pi r^2 \times \frac{10}{12} \times 200$

$C_2 = \pi r^2 \times \frac{10}{12} \times 200$

$\therefore C = 250 \times 2\pi r \times \frac{V}{\pi r^2} \times \frac{8}{12} + \pi r^2 \times \frac{10}{12} \times 200 = \frac{1000}{3} \cdot \frac{V}{r} + \frac{500}{3} r^2$

$\frac{dc}{dr} = 0$

Class test ⇒ Next Tuesday — 17.11.2015

Only on this class

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17.11.2015

* Water Supply network Design —

1. Method of supply

2. Distribution system

3. Water demand ⇒ future water demands, not present
   ⇓
   at the rate of water usage or design period.

4. Normally design flow = 3 × A_v flow
   ↓
   Average flow

5. Formula used

- Factors of design

1. Contour map of the area
2. Detail plan ⇒ mainly street Location
3. Future demand
4. Flow = 3 – 4 ft/s ⇒ 1st assumption ⇒ mainly diameter selection
   ⇓
   On the basis of this, pipe dia is determined.
   ⇓
   Then, head loss = $f \cdot \frac{L}{D} \cdot \frac{v^2}{2g}$ is calculated

5. Design life ⇒ depends on the material used and cost
   ↓
   it is a prime factor

- Normally design life = 30 years
but SS হলে life একটু বেশি হবে।
- Only design করলেই হবে না, ঐ cost must be recovered by the design.

* Network Analysis —

Different methods are there —

1. Hardy Cross Method ⇒ mostly used

This method depends on two factors —

a) Σinflow = Σoutflow at any ~~section~~ loop.

and b) Σheadloss = 0 must satisfy in any loop.

- But main drawback is — without any loop, this method can't be used.

V. Imp.

Derivation —

According to Hardy Cross —

$$H \propto Q$$

$$\therefore H = KQ^x$$

In any flow / loop, according to Hardy Cross method, $\boxed{\Sigma H = \Sigma K Q^x = 0}$

Accurate flow/discharge —

$$Q = Q_a + \Delta$$

Q_a → Q assumed; Δ → correction

and $\Sigma H = \Sigma K (Q_a + \Delta)^x = 0$

$$\Rightarrow \Sigma K Q_a^x + \Sigma x K Q_a^{x-1} \Delta + \frac{x(x-1)}{2} \Sigma K Q_a^{x-2} \Delta^2 + \cdots = 0$$

As $\Delta \approx$ very small, so higher power of $\Delta \approx 0$.

$$\therefore \Sigma K Q_a^x = - \Sigma x K Q_a^{x-1} \Delta$$

$$\Rightarrow \boxed{\Delta = - \frac{\Sigma K Q_a^x}{\Sigma x K Q_a^{x-1}}}$$

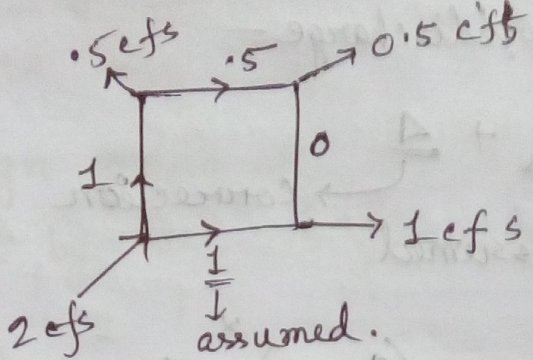
or,

$$\boxed{\Delta = - \frac{\Sigma H}{x \Sigma H/Q}}$$

Imp.

• Mathematical Problem —

* Suppose a closed loop —



then either clockwise / anticlockwise loop flow direction is assumed. Then head loss is determined.

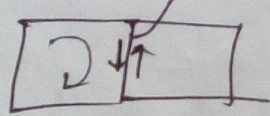
• According to Hazen William —

$x = 1.85$ → According to Hazen William

or normally, $x \approx 1.7 - 2.2$

The method is repeated for successive trials and the accurate discharge is determined when $\Delta \approx 0$.

If two loops ⟹



এই pipe-এ দুটো correction হবে,

21.11.15

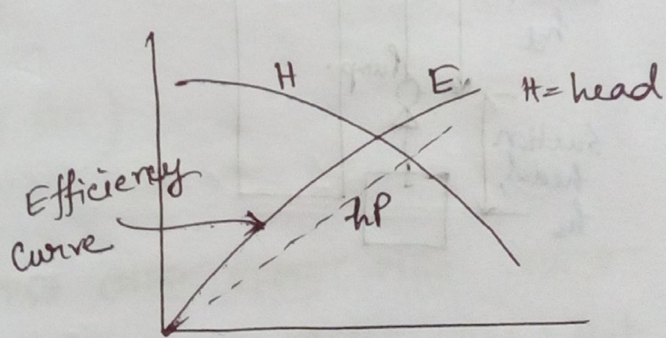
Use of pump:

- Overhead reservoir
- Distribution system
- অনেক লম্বা line হলে pumping boosting করতে হবে।
- low head -এ কখনও কখনও পানি উঠাই।
- কখনও High head-এ উঠাই (tall building)

এগুলোর উপর ভিত্তি করে pump use করা হয়।

Centrifugal pump ⇒ mostly used

Q বাড়লে Head কমবে



⇒ for designing a pump

$$h_p = \frac{HQ}{3960}$$

H = total head (ft)
Q = flow in gpm
⇓
Habibur Sir-এর বইয়ে ভুল আছে

Use of pump:—

- বাড়িতে underground reservoir থেকে overhead tank-এ নিতে
- fire fighting ⇒ আলাদা tank ও থাকতে পারে

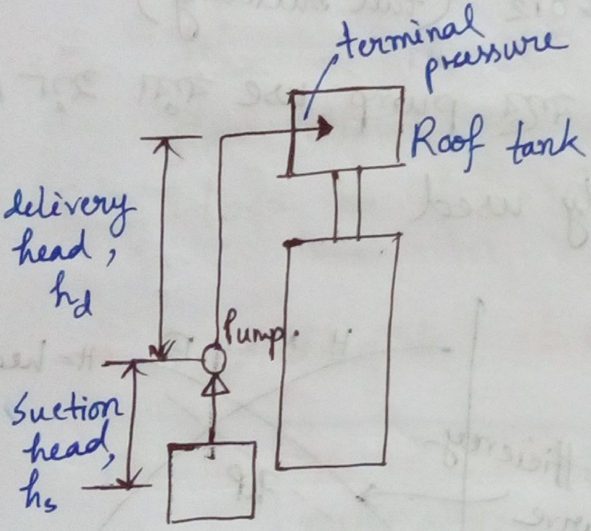
অনেক স্থানে fire fighting-এর জন্য আলাদা reservoir-ও থাকে।

Scanned by CamScanner

— It should be ensured that ⇒

- flow ঠিকমত যায় (velocity of flow)
- pressure

- 60 person, perhead consumption 60 gpcd.
  ↓
  can vary place to place



(*) Generally বাসা/বাড়িতে ২ বার পানি উঠায় & প্রতিবার 1 hrs করে উঠানো হয়
i.e. সকালে & বিকালে

- $h_f = f \cdot \frac{L}{D} \cdot \frac{v^2}{2g}$
  ↓
  head loss বের করতে হবে

(*) কিছু minor head loss হবে as we use pump.

(*) due to — 1) bent & 2) Pump

- একটা terminal pressure লাগবে (min^m 5 psi)
  ↳ একে head-এ নিতে হবে

Let, $h_m = 2$ psi

So, $H = h_s + h_d + h_f + (h_m + h_t)$
psi ⇒ feet-এ নিতে হবে

(*) Normally atm. pressure-এ যে head হয় —
atm. pressure ↓ 13.82 psi
head ↓ 34′ of H_2O

1 psi = 2.46′ ✓

(*) ·Now, total gallons per day = 60×60 = 3600 gpd.

1 pumping hour = 1 hrs/day

$\therefore Q = \frac{3600}{60}$ gpm

If we get the value of h_p = 5 hp.

- বাজার থেকে 5 hp exactly আনা যাবে না।
  as pump 100% effiuency তে চলে নয়। → So graph থেকে Head(H) & Efficiency (E) থেকে h_p বের করে নিতে হবে।

$$BHP = \frac{h_p}{E} = \frac{HQ}{3960E}$$

(60 to 70% efficiency ধরে নিব)

(*) যখন অনেক দূর থেকে i.e. পদ্মা থেকে ঢাকায় পানি আনতে অনেক বেশি hp i.e. 1000 hp এর pump-ও লাগতে পারে। But যতটা pump আমার দরকার তার at least 1/3 standby থাকবে।

as ২টা লাগলে 1 টা standby
↓
by rotation চালাতে হবে

⊛ Last year ⇒ প্রায় একই থাকবে

- math করতে হবে (exam এ থাকবে)
- কিছু type এর pump এর def^n (exam)

Various formulas are used —

$$h_f = f \cdot \frac{L}{D} \cdot \frac{V^2}{2g}$$

$$V = \frac{1.486}{n} R^{2/3} S^{1/2} \quad \text{(Manings formula)}$$

$$V = C\sqrt{RS}$$

- Minor loss assume করে নিতে হবে (1–2 psi, ≯ 5 psi)

⊛ Fig 6.1 ⇒ monogram দেওয়া আছে (পড়তে হবে) → Imp. for exam

⊛ approximately { • $f = 0.4$
  • $f = 0.01$ (if $4f$ is used) }

⊛ $n = 0.013$

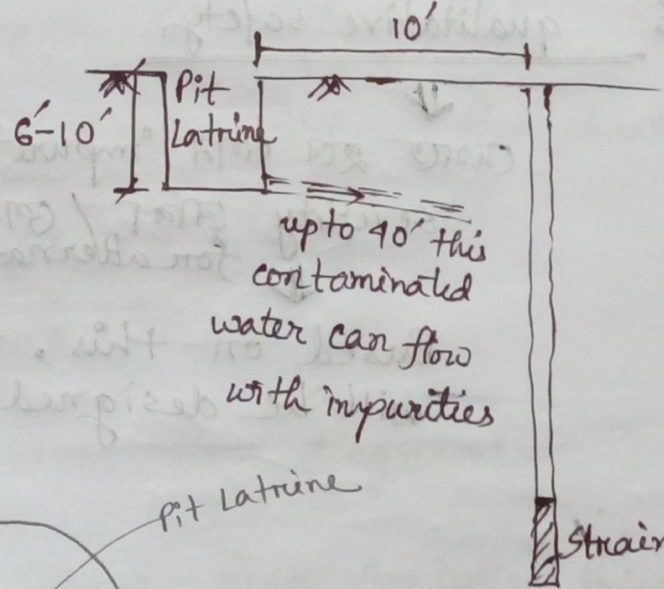
↓

old হলে roughness বেড়ে যাবে, friction বাড়বে, n বাড়বে।

(Next class ⇒ Water ~~Septic~~ Safety Plant ⇒ BUET বই আনব)

01.12.2015

- Water supply system consists of –
  - Source
  - Collection System
  - Treatment Units → capacity এর থেকে বেশি H_2O treat করতে হলে safety is a must.
  - Distribution



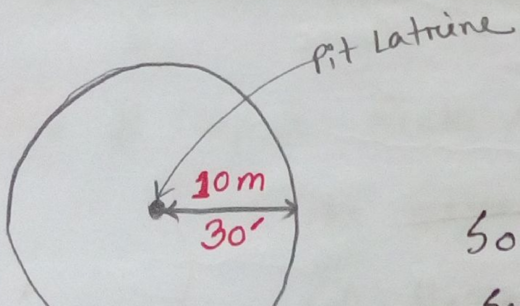
⇓

So normally contaminated H_2O এর নিচে আসার কথা না।

⇓

but কোন leakage থাকলে strainer–এ যেতে পারে।

So for Safety ⇐



⇓

(এই পুরা circle জুড়ে কোন tubewell থাকতে পারবে না। এর থেকে দূরে i.e. এই circle এর বাইরে থাকতে হবে।)

- by keeping 10 m / 30′ away from the Latrine, Contamination from source can be protected.

⇓

But there may be other impurities i.e. Fe, As etc.

⇓

If they are beyond tolerable limit, then comes qualitative safety

⇓

দেখতে হবে কোন impurities-র severity বেশি / কোনটার কম for alternative sources.

⇓

Based on this, the plant will be designed.

08.12.15

Water Safety Plan

- Background
- Concept of WSP
  - – - - -
  - – Identification
  - – Monitoring
  - – Overcome
- Major Activities in WSP

Imp. * Developing a WSP (flow chart)

- Step 1 :
- Step 2 :

– System flow diagrams –

Imp. • Step 3 : Risk Analysis, Prioritization & Controls

– The major tasks –

(A) Hazard identification & Risk Assessment

(B) Identification of Controls

(C)

(*) General approach to risk analysis

Table

1. High (H)
2. Moderate (M)
3. Low (L)

Imp. for math — ii: Semi quantitative approach

Risk Score = Likelihood x Impact.

- Estimation of "Risk Score" and "Risk Categories"

⇓

(Matrix)

v.v. Imp

		Likelihood		Impact
Bacteria	→	almost certain		Major
Arsenic	⇒	Severity		
		বেশি	———	Major
		কম ≤ .05 mg/L	———	Minor
Fe	⇒	Almost certain	———	Minor ⇒ This is because Fe does little harm to people.

Math

Pit Latrine- এর কাছে / দূরে tubewell

⇓

Then দেখাতে হবে strainer পর্যন্ত contamination যেতে পারবে কি না। এই অনুযায়ী likelihood & Impact বের করবে।

⇓

(Problem from book)

— Ex 1.(a), 1.(b), 2(a), 2(b) etc...