UNIT-4

* **Canal Outlet**
  - also called module
  - It is a small structure built at head of watercourse so as to connect it with a minor or distributary channel.
  - It should be simple, cheap, efficient & easy to handle

* **Requirements of Good Canal Outlet**

(1) Module on decided principles
  - module should fit well on decided principles
  - ex → able to pass constant & fixed discharge
    - change capacity year to year acc. to requirement

(2) Simple
  - easily constructed & easily maintained ~~or~~ modul are simple modules.

(3) Efficient
  - work efficiently with a small working head

(4) Cost
  - cheap
  - required in large no.s - cost should be less

(5) Strong
- sufficiently strong to avoid periodic maintenance

(6) Interference
- no interference should be done by cultivators & local people
- If done, should be easily detectable.

* Types of outlets

Outlets

- Non-modular outlets
  - open sluice
  - Submerged pipe outlet
- Semi Modules/ Flexible
  - free pipe outlet
  - venturi flume outlet
  - open flume outlet
  - Adjustable Orifice semi module
- Rigid/ Modular outlets
  - Gibb's module
  - Khama's rigid module
  - foote module

→ Non-modular Outlets
- discharge depends upon difference in head b/w distributary and water course.
- varies widely.

→ Semi Modules
- also called flexible modules
- discharge depends upon only water level of distributary
- discharge inc with ~~to~~ rise in distributary water level

→ Modular Outlets
- also called rigid modules
- discharge is constant & fixed
- ~~X~~ dependance on fluctuations of water level.

* Criteria for Judging Performance.

(1) Flexibility (F)

F = rate of change of discharge of outlet / " " " " " " distributary

$$F = \frac{dq/q}{dQ/Q}$$

here, q = discharge through outlet

Q = discharge through distributary

$\rightarrow q = C H^m$ — (1)

here, C & m are const. and
H is head at outlet

$\rightarrow Q = K . y^n$ — (2)

here, k & n are const and
y is depth of H_2O at distb.

now, $dq = C m . H^{m-1} dH$ (diff. eq (1))

$dQ = k n . y^{n-1} dy$ (diff. eq (2))

now, $\frac{dq}{q} = \frac{\cancel{C} m H^{m-1} dH}{\cancel{C} H^m} = \frac{m \cancel{H^m} dH}{H . \cancel{H^m}}$

$$\boxed{\frac{dq}{q} = \frac{m \, dH}{H}}$$

also, $\frac{dQ}{Q} = \frac{k n y^{n-1} dy}{k y^n}$

$$\boxed{\frac{dQ}{Q} = \frac{n}{y} dy}$$

we know, $F = \frac{dq/q}{dQ/Q} = \frac{m}{n} \cdot \frac{y}{H} \cdot \frac{dH}{dy}$

Also, $dy = dH$ [change in head = change in depth]

$$\boxed{F = \frac{m}{n} \cdot \frac{y}{H}}$$

(2) Proportionality (P)

P ⇒ rate of change of outlet discharge = rate of change of channel discharge

$$dq/q = dQ/Q$$

Thus, $\boxed{F = 1}$

$$\frac{m}{n} \cdot \frac{y}{H} = 1 \Rightarrow \frac{H}{y} = \frac{m}{n}$$

$$\boxed{\frac{H}{y} = \frac{m}{n} = \frac{\text{outlet index}}{\text{channel index}}}$$

(3) <u>Setting</u> (SeT)

$$SeT = \frac{H}{y} = \frac{\text{outlet index}}{\text{chanel index}}$$

<u>for example</u>(1) → $n = 5/3$ → trapezoidal chanel
$m = 1/2$ → orifice outlet

$$Set = \frac{H}{y} = \frac{m}{n} = \frac{1/2}{5/3} = 0.3$$

(2) → $n = 5/3$
$m = 3/2$ → wier type outlet

$$Set = \frac{H}{y} = \frac{m}{n} = \frac{3/2}{5/3} = 0.9$$

This means, for (2) example wier type outlet will be P if when outlet should be set at 0.9 times depth below water surface

(4) Sensitivity (S)

$$S = \frac{\text{rate of change of discharge of outlet}}{\text{" " " " water level of channel}}$$

for rigid modules, $\boxed{S = 0}$
bcz discharge = fixed

for flexible modules, water level at channel is indicated by Gauge.

$$S = \boxed{\frac{dq/q}{dG/y}}$$

⇒ Rltn b/w Sensitivity & Flexibility (S & F)

$$F = \frac{dq/q}{dQ/Q} \quad \Big| \quad \text{also, } dQ/Q = \frac{n}{y}\,dy$$

$$F = \frac{dq/q}{(n/y)\,dy} = \frac{1}{n}\left[\frac{dq/q}{dy/y}\right]$$

But, $dQ = dy$ | $F = \frac{1}{n} \cdot S$

$$\boxed{S = nF}$$

→ ↑ variation in discharge = ↑ S of outlet

→ $S = 0$ → rigid & non-modular outlet

Type of Flexible / Semi-Module Outlets

→ Open Flume Outlet
- weir type outlet
- constricted throat - super critical velocity ensured
- expanding flume on d/s - formation of jump
- hydraulic jump formed - outlet discharge independent
  - semi-module
- example → Punjab open Flume Outlet

u/s approach - curved
d/s approach - straight
length of throat - 2H
width " " - W
width of flume at d/s - $(W + 0.3)$ m

[H = head over crest measured from FSL of channel]

- discharge ⇒ q | $\boxed{q = C_d W H^{3/2}}$

here, C_d = coeff of discharge < 1.71

W (m)	C_d
0.06 - 0.089	1.60
0.09 - 0.119	1.64
over 0.12	1.66

$\rightarrow P = \frac{H}{y} = \frac{m}{n} = \frac{3/2}{5/3} = 0.9$

Thus, efficiency = 80-90%

⟹ Example ⇒ Design a semi modular pipe outlet for a discharge of 0.08 cumec on a distributary with FSD of 1m & working head of 0.75 m.

Ans → $q = CA\sqrt{2gh}$ (simple outlet)

$$C = \left(\frac{d}{1.5d + fL}\right)^{1/2}$$

→ here, $L = 12\,m$ & $f = 0.02$, $d = 25\,cm$ [assumed] $= 0.25\,m$

$$C = \left(\frac{0.25}{1.5(0.25) + (0.02 \times 12)}\right)^{1/2}$$

→ $\boxed{C = 0.638}$

→ $q = 0.08$ cumec & $A = \frac{\pi}{4}(0.25)^2 = 0.049\ m^2$

$$q = CA\sqrt{2gh}$$

$$0.08 = 0.638 \times 0.049\sqrt{2 \times 9.8 \times H}$$

$$\boxed{H = 0.33\,m}$$