Ref.

1) Basic Coastal Engr — Sorensen

2) Dock & Harbour Engr (2nd edition) — Oza.

Sec-B

Shangi Madam

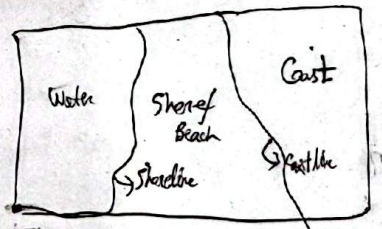
[15-06-18]

Lec-1: Intro to Coastal Engr, Coast & Coastal features

Imp

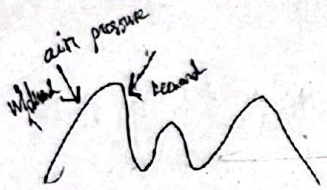
Diff b/w Ocean & Sea:

- Largest ocean & largest sea —
- Coastal zone
- Coast.



[17-06-26]

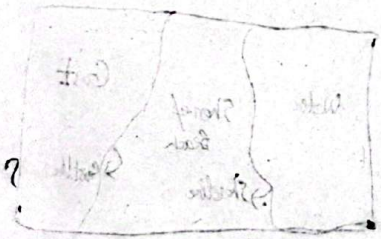
Lec-2-4:- Tides & Currents.



- Astronomical tide.
- Meteorological tide

Wave due to —

- # Earthquake
- # Wind
- # Ship
- # Gravitational force of moon & sun
- # Volcanic activity

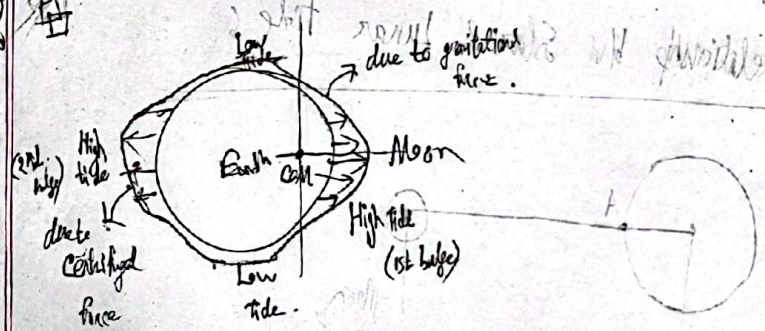


Why Tide changes ?

Earth → Moon Sun.

Moon ↑ Earth → Sun

Moon's gravitational force is 46% more than Sun's.



Intertidal zone: It is the strip of seashore that is submerged at high tides & exposed at low tide.

Tidal range: The diff in water level b/w high & low tides.

High = 5 m
Low = 1.5 m
Tidal range = 3.5 m.

Tidal period:

- The time b/w high tides.

For Bd, 2 high tides & 2 low tides.



Earth → 24hr → 360°
1° → 52 minute

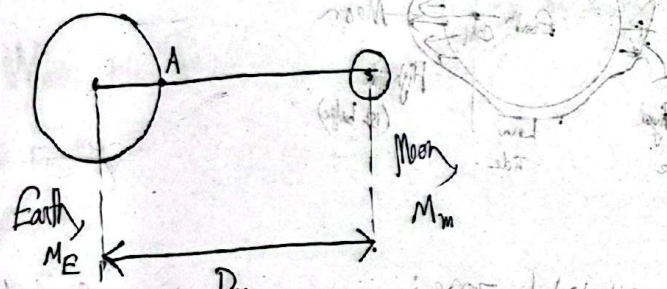
2020-06-26

Imp

Why high tides are 12 hrs & 25 mins apart?

Derivation

Relationship b/w Solar & Lunar tide:



Let,

M_E = Mass of earth

M_m = Mass of moon

M_S = Mass of sun

D_m = Distance from the center of earth to the center of the moon.

D_S = Distance from the center of earth to the center of the sun.

R = Radius of earth

k = Constant of gravitation.

Considering pt A facing the moon,

Tide producing force F_m of the moon on unit mass of A is given by

$$F_m = kM_m \left[\frac{1}{(D_m - R)^2} - \frac{1}{D_m^2} \right]$$

$$= kM_m \left[\frac{R(2D_m - R)}{(D_m - R)^2 D_m^2} \right]$$

Assuming radius of the earth R very small in comparison to the dist between earth & moon,

$$F_m \propto kM_m \left(\frac{2R}{D_m^3} \right)$$

Similarly, tide producing force F_S of the sun on unit mass at A is given by

$$f_S \propto kM_S \left(\frac{2R}{D_S^3} \right)$$

Hence, $\frac{F_s}{F_m} = \frac{M_s}{M_m}\left(\frac{D_m}{D_s}\right)^3$

Now, Mass of sun, $M_s = 2\times10^{27}$ Metric tons

Mass of moon, $M_m = 7.3\times10^{22}$ Metric tons.

$D_s = 149758000$ km.

$D_m = 384835$ km

$\therefore \frac{F_s}{F_m} = 0.464$

Tidal Pattern:

Semi diurnal.
Diurnal
Mixed semidiurnal

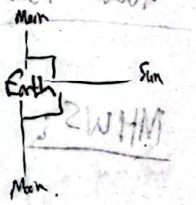
* Graphical representation of Tidal terms. [24-06-26]

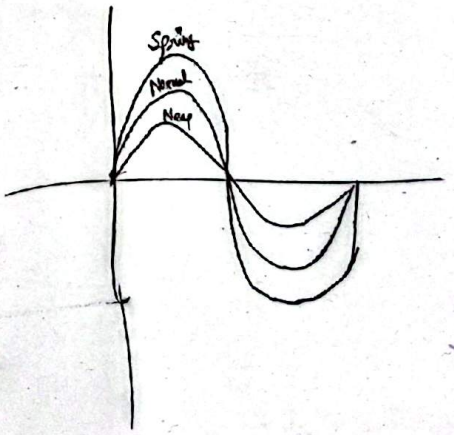
Spring Tide:

Full Moon: Earth, Sun

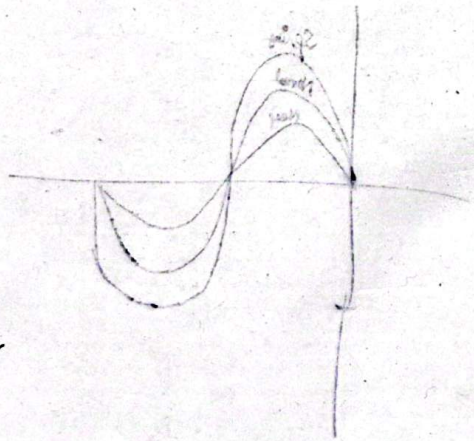
New moon: Earth, Sun

Neap Tide:





- **Flood current:** Towards east. Tidal phase → Flood tide
- **Ebb current:** Towards ocean. Tidal phase → Ebb tide
- **Tidal curve:**
- **Tidal range:**
- **Tidal level:**
- **MHWS:**
- **MLWS:**
- **MHWN:**
- **MLWN:**
- **Spring range:**
- **Neap range:**



- **HAT:**
- **LAT:**
- **Tidal bores:**

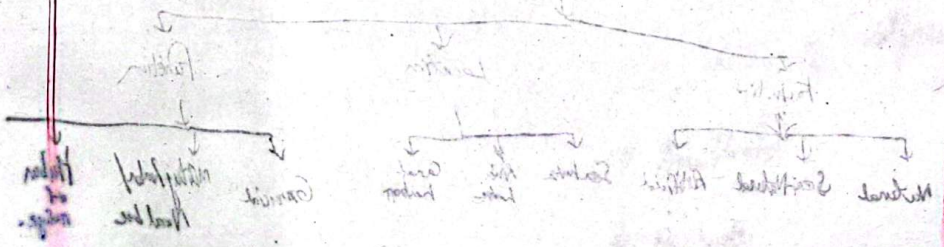
29-06-26

* Characteristics of Tidal bore.

* Tidal stream, Tidal flow

* 1 knot = 1 Nautical mile/hr = 1.852 km/hr.

* Tidal char in Bd.



Compulsory

lec-6-7: Ports & Harbours

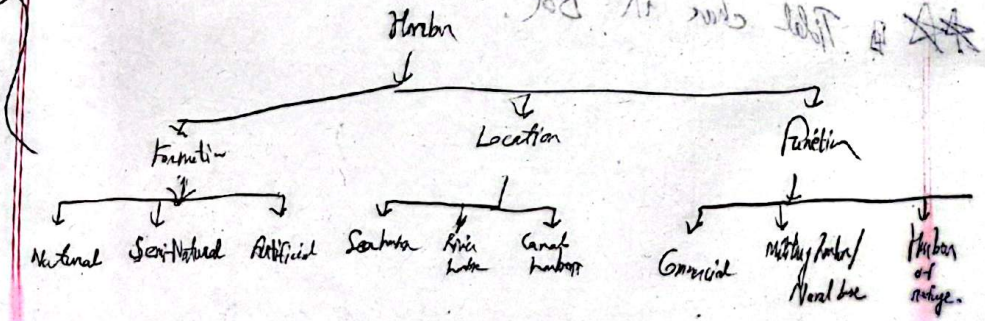
[01-07-25]

* Port vs Harbor

Types of ports:

Inland port
Fishing port
Dry port
Warm water port
Seaport
Ocean port
Free port

Types of harbors:



atleast one exp

[06-07-25]

Port terms:

Port of call
Marine terminal → Passenger terminal, Oil terminal
Offshore terminal

Site selection factors to be considered for ports:

Features of harbor:

Harbor entrance
Approach channel
Turning basin
Sheltered basin
Wharves & Quays
Jetties & piers
Locked basin
Dry docks & slipways
Ancillaries
Breakwater

Harbor layout factors:

(1st fig).

Layers & Components of Harbour.

Requirements of a good harbour

Harbour depth factors:

[08-07-26]

Lec-08: Coastal Processes & Sediment Transport

Coast:

Size of a wave depends on —

(i) length of time the wind has been blowing
(ii) strength of the wind
(iii) Fetch — how far the wind has blown.

Diff types of waves with characteristics:

* Constructive
* Destructive

(swash, backwash)

(Wavelength, Frequency)

Continental Shelf:

[15-07-26]

Coastal processes:

Effects of coastal development on coastal zone processes (with exp)

Processes of Erosion

Landforms of Erosion

Erosion structures

Hard [Concrete, Reinforcement etc.]

Soft [Nature based solution]

Modes of Sediment Transport:

Bed load transport

Suspended load transport

Wash load transport

(X3)

Beach profile with fig: [water levels must be included]

Backshore

Foreshore / Intertidal zone

Nearshore

Offshore

Surf zone

Surf zone

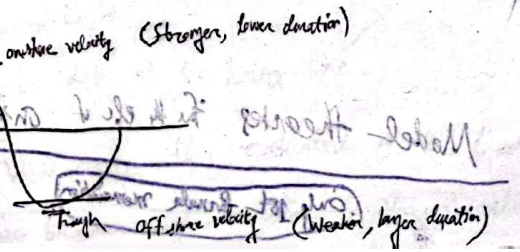
Breaker zone

Shoreface.

Sediment transport:

Off shore transport

On shore transport.



Mechanisms causing beach profile change:

1. Wave motion
2. Gravity
3. Undertow & Rip current
4. Turbulence from breaking waves
5. Wind effects.

PDF 8.2 P-261

Model theories for the calculation of longshore drift:

(i) Energy flux model

(ii) Energetic model.

(iii)

Model theories for the elc of onshore-offshore Transport:

Only for formula memorization

No numerical

Name only

Only Numericals

Derivation No need

Final

To-Know notes

Prediction of potential longshore Transport rate:

The potential longshore sediment transport rate,

$$P_L = (EC_g)_b \sin\alpha_b \cos\alpha_b$$

$$= (EC_g)_b \sin 2\alpha_b \times \frac{1}{2}$$

Where, E_b is the wave energy evaluated at the breaker line.

$$E_b = \frac{\rho g H_b^2}{8}$$

& C_{g_b} = wave group speed at the breaker line

$$= \sqrt{g d_b} = \sqrt{g \frac{H_b}{K}}$$

K → Kappa

(Kappa) K = breaker index $= \frac{H_b}{d_b}$

H_b = breaker height

d_b = water depth at the breaker line.

$(ECg)_b$ = Wave energy flux evaluated at the breaker zone.

α_b = Wave breaker angle relative to the shoreline.

Immersed weight transport rate,

$$I_l = K P_l$$
$$= K (E C_g)_b \frac{1}{2} \sin 2\alpha_b$$
$$= K \left(\frac{\rho g H_b^2}{8}\right)_b \left(\frac{g H_b}{K}\right)^{\frac{1}{2}} \frac{1}{2} \sin 2\alpha_b$$

$$\Rightarrow I_l = K \left(\frac{\rho g^{\frac{3}{2}}}{1.6 K^{\frac{1}{2}}}\right) H_b^{\frac{5}{2}} \sin 2\alpha_b$$

The longshore sediment transport rate is expressed as the potential volumetric longshore transport rate (Q_l).

$$Q_l = \frac{I_l}{(\rho_s - \rho) g (1-n)}$$

where,

ρ_s = Mass density of the sediment grains
= 2650 kg/m³ for quartz density sand

ρ = mass density of water
= 1025 kg/m³ for 33 ppt salt water

n = in place sediment porosity = 0.4

g = Acceleration due to gravity = 9.81 m/s²

K = 0.78 for flat beaches
(kappa) > 1.0 (depending on beach slope)

$$K = 0.05 + 2.6 \sin^2(2\alpha_b) + 0.007 \frac{u_{mb}}{w_f}$$

w_f = fall velocity

u_{mb} = Maximum oscillatory velocity magnitude

$$\Rightarrow u_{mb} = \frac{K}{2} \sqrt{g d_b}$$

* Waves having an rms wave ht of 2m break on a gently sloping beach of a wave breaking angle = 4.5°. The temperature of the seawater is 20°C & the fall velocity of the sediment is 13.1 cm/sec. Assume $K = 1.0$. Calculate the potential volumetric longshore transport rate along the beach.

$$Q_l = K \left[\frac{\rho \sqrt{g}}{16 K^{\frac{1}{2}} (\rho_s - \rho)(1-n)}\right] H_b^{\frac{5}{2}} \sin 2\alpha_b$$

Sol: $d_b = 2m$, $u_{mb} = 2.21$ m/s, $K = 0.23$, $Q_l = 0.0042$ m³/sec.
= 362.8 m³/day

Lec-11-12 : Delta & Its characteristics [22-07-25]

Formation of delta / How sediment of river ends up being triangular? 5 pts.

Flocculation process in Delta formation / Why clay particles do not settle at river mouth?

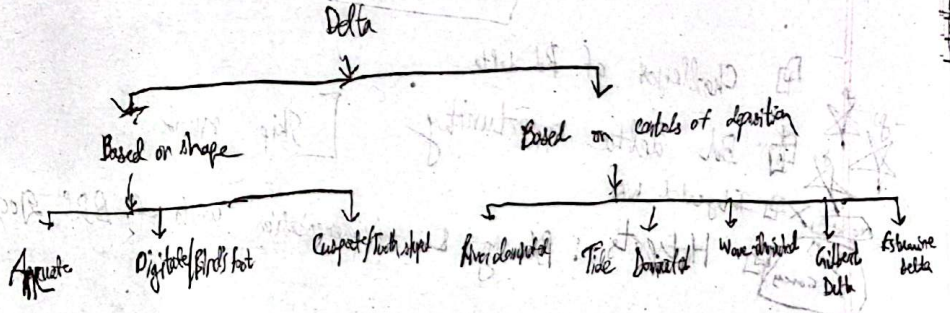
Composition of a delta / Layers of particles in delta with (fig):
(i) Bottom set beds
(ii) Foreset beds
(iii) Topset beds

Geomorphological elements of delta / Planform view:
(i) Delta plain
(ii) Delta front
(iii) Pro delta

Parts of delta:
(i) Upper deltaic plain
(ii) Lower deltaic plain
(iii) Subqueous delta

Stages in Delta Formation: (with (fig) must) (plan)
* Stage 1
# Stage 2
@ Stage 3

Types of delta: (with 1 example)



* BL → Tide Dominated Delta
* Eustasy → Land changes
* Isostasy → Tectonic plate shift (Geologic)

- Sea level rise:
- Causes of sea level rise:
- Impacts of sea level rise:
- Relation b/w Global & Local sea level:

[29-07-25]

Lec-13: Bd Delta Plan (BDP) 2100

- Challenges of Bd delta.
- Bd delta opportunity [Skip number]
- Integrated WR
- Hotspots: Planning & implementation units of BDP 2100:
- Hotspot issues & challenges
- Vision, goal
- Strategies for Hotspots [4/5, pts]
- Coast cutting

Lec-14&15: Tidal Theories & Tide Prediction [30-08-25]

- Tidal Theories:
  - # Newton's statical or equilibrium theory
  - # Laplace theory / Dynamic theory
- Priming of Tide & Lagtg of tide with fig
- Tide tables:
- Tide gauges:
- Prediction of tide:
  - 2 elements:
    - Time of occurance of tide
    - Height of tide above datum
  - 2 methods:
    - using non-harmonic constant
    - using harmonic constant.

- Age of tide:
- Lunitidal interval:
- Mean establishment / Mean lunitidal interval:
- Vulgar establishment:

Mean establishment ⇌ Vulgar establishment ± lagging correction

- Graph
- Non-Harmonic constant method:
- Chart & Theory

* Find the time of afternoon high water at a place with the following data:

Time of the moon's transit on that day = 4h 40 m
Mean establishment = 3h 10 m
Age of tide = 2 days

Sol^n: We know that the moon falls behind the sun at a rate of 50 m per day. Hence, at the birth of tide, 2 days earlier, the time of moon's transit = 4h 40 m − (2×50) m
= 3h 0 m.

From the table, corresponding to the time of moon's transit of 3h 0 m, the correction for priming = −41 m.
(lagging if (+))

Therefore, Lunitidal interval = Mean Establishment + Correction
= 3h 10 m − 41 m
= 2h 29 m.

Now, the time of high water = Time of moon's transit + Lunitidal interval
= 4h 40 m + 2h 29 m
= 7h 09 m
= 7:09 PM.

* Find the time of afternoon high water at a place with the following data:

Time of the moon's transit on that day = 3h 20 min

Mean establishment = 3h 15 min

Age of tides = 3 days.

Soln:

3 days earlier, the time of moon's transit

= 3h 20 m − (3×50)m

= 50 m.

Correction for priming = −13.33 m

≈ −13 m

[If 13.33 m, then 14 m]

Lunitidal interval = 3h 15 min + (−13 min)

= 3h 02 hrs

Time of high water = 3h 20 m + 3h 02m = 6:22 pm.

Mean Eqo: F =

Compulsory

Lec 16-17: Types & Fn's of Coastal Structures

24 of 26

PDF

Types of coastal struc:

(i) Hard

(ii) Soft

Fn's of Coastal structures:

(i) Coastal protection

Sea dike:

Sea Wall:

Revetment:

Bulkhead:

Groin: "Till high or low"

30-08-26

- Detached breakwater: — Small, non-shore stone, multiple. Func — Reduce erosion (only)
- Reef breakwater: — Last 2 para — No need.
- Submerged sills:
- Beach drain:
- Beach nourishment & dune construction:
- Breakwater:
- Floating breakwater: — only Func
- Jetties:
- Training walls:
- Storm surge barriers:
- Pipelines:

- File structures:
- Scour protection

PDF — Page 9 [Any 8-10 → Obj & Func's]

from Page-14:

Figure VI-2 [1, 3, 7, 8 (Top), 10, 13, 17, 25]

Page-27

- Failure: — Defn

Design failure
Load exceeding failure
Construction failure.
Deterioration failure.

Page-37

Fig ✗

Seawall/Revetment failure due to which reason?

Page-50

Fig

Failure of floating breakwater due to which reason?

Sea dyke - failure ; No fig.

Vertical.

Floating — only names.

PDF (Appendix E) page-97

Completed

31-08-20

Revetment design:

Design wave height, H = 4.20 ft

Design wave period, T = 4.25 sec

RL of the road level = +11 ft MLLW

Storm surge height = 3'

50 year high water level = +1.91' MLLW.

MHHW = +1.42' MLLW

Bed level at the end of bank slope = +1.00 MLLW.

Bottom slope of sea bed = 1:10

Sol:

Design water level = Storm surge height + 50 yr water level

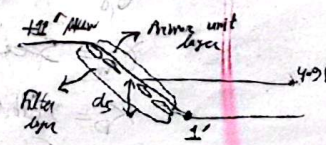
= 3' + 1.91' = 4.91' (MLLW)

(a) Breaking wave criteria:

d_s = water depth at the structure = 4.91 - 1.00 = 3.91'

T = 4.25 sec.

Nearshore bottom slope, $m = \frac{1}{10} = 0.1$



$$\frac{d_s}{gT^2} = \frac{3.91}{32.2 \times 9.25^2} = 0.0067$$

From graph, $\frac{H_b}{d_s}$ Vs. $\frac{d_s}{gT^2}$,

$$\frac{H_b}{d_s} = 1.45$$

$$\therefore H_b = 1.45 \times 3.91 = 5.67' > 4.2' \qquad \left[H \le \begin{cases} H_b \\ \text{Design wave ht} \end{cases}\right]$$

$\therefore$ Using $H = 4.2'$ for design.

(b) Armor size determination:

$$W = \frac{\gamma_R H^3}{K_D \left(\frac{\gamma_R}{\gamma_w} - 1\right)^3 \cot\theta}$$

W = Required individual armor unit weight, lb
(or W_{50} for graded riprap)

γ_R = Specific weight of the armor unit, lb/ft^3

γ_w = Specific weight of water at the site

K_D = Stability coefficient

θ = Structure slope.

(i) Riprap:

$\cot\theta = 2$

$\gamma_R = 165\ lb/ft^3$

$\gamma_w = 64\ lb/ft^3$

$K_D = 2.2$

$$W_{50} = \frac{165 \times (4.2)^3}{2.2\left(\frac{165}{64} - 1\right)^3 \times 2} = 705\ lb > 500\ lb.$$

Graded riprap this large may be difficult to obtain economically.

(ii) Quarrystone:

$\cot\theta = 1.5$ to 3.0

Assume $\cot\theta = 2$

$K_D = 2$

$$W = \frac{165 \times (4.2)^3}{2\left(\frac{165}{64} - 1\right)^3 \times 2} = 780\ lb.$$

The range of armor stone weights for a cover layer of quarrystones could be varied from 0.75 W to 1.25 W or 585 lb to 975 lb with about 50 % of the individual stones weighing more than W (780 lb).

Armor layer thickness,

$$r = nk_\Delta \left(\frac{w}{\gamma_w}\right)^{1/3}$$

r = Layer thickness in feet.

n = Number of armor units layer.

K_Δ = layer coefficient = 1.00.

$$\therefore r = 2 \times 1 \times \left(\frac{78}{165}\right)^{1/3} = 3.4'$$

Number of quarrystones per area,

$$N_r = A n K_\Delta \left(1 - \frac{P}{100}\right)\left(\frac{\gamma_w}{w}\right)^{2/3}$$

P = Average porosity of the cover layer = 37 %.

Using $A = 1000\ ft^2$.

$$N_r = 1000 \times 2 \times 1 \left(1 - \frac{37}{100}\right)\left(\frac{165}{78}\right)^{2/3}$$

≈ 450 stones per $1000\ ft^2$.

(d) Wave runup estimation:

$$\frac{H_s}{H_{mo}} = \exp\left[C_0 \left(\frac{d}{gT_p^2}\right)^{-C_1}\right]$$

H_{mo} = Energy based height of the zeroth moment.

C_0, C_1 = Regression coefficient given as 0.00089 & 0.834 respectively.

g = Acceleration due to gravity

T_p = Period of peak energy density of the wave spectrum.

$$\therefore \frac{4.12}{H_{mo}} = \exp\left[0.00089 \left(\frac{15}{32.2 \times 4.25^2}\right)^{-0.834}\right]$$

$$\Rightarrow \frac{4.12}{H_{mo}} = 1.019$$

$$\Rightarrow H_{mo} = 4.12'$$

Maximum runup:

$$\xi = \frac{\tan\theta}{\left(\frac{2\pi H_{mo}}{gT_p^2}\right)^{1/2}} = \frac{0.5}{\left(\frac{2\pi \times 4.12}{32.2 \times 4.25^2}\right)^{1/2}} = 2.37$$

$$R_{max} = \frac{a\xi}{1 + b\xi}$$

R_{max} = Maximum vertical height of the runup above the SWL.

a, b = Regression coefficient determined as 1.022 & 0.247 respectively.

ξ = Surf parameter.

$$\therefore \frac{R_{max}}{H/2} = \frac{1.022 \times 2.37}{1+(0.247 \times 2.37)} = 1.53$$

$$\Rightarrow R_{max} = 6.29'$$

Crest elevation = $(4.91 + 6.29)$ ft

$= 11.2$ ft

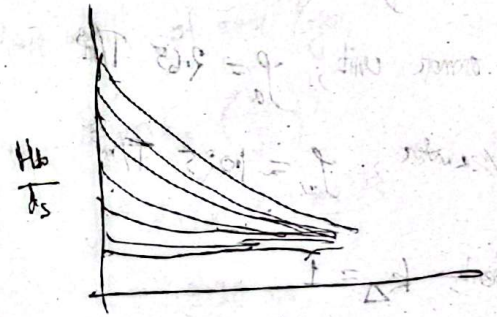
≈ 11.25 ft

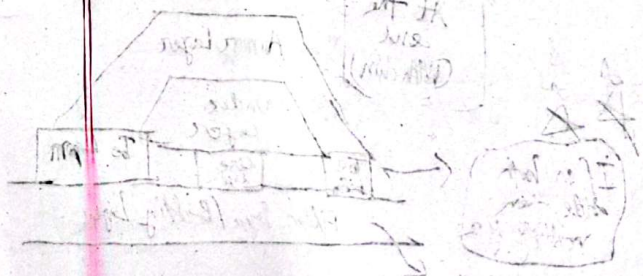
Page-09

(c) Filter requirements:

1. Quarrystone revetment: 1st two lines,

*





[14-09-26]

Seawall (Rubble mound) design:

will be given { Significant wave height, $H = 1.524$ m

Depth of water, $d = 2.524$ m [If d is not given, $d = H + 1$]

will be given { Time period of approaching wave, $T = 7.468$ sec

Stability coefficient, $K_D = 2$

Unit weight of armor unit, $\gamma_a = 2.65$ T/m^3

Density of seawater, $\gamma_w = 1025$ T/m^3

Layer coefficient, $k_\Delta = 1$

will be given { Slope, $\phi = 1$ in 1.5

$\cot\phi = 1.5$

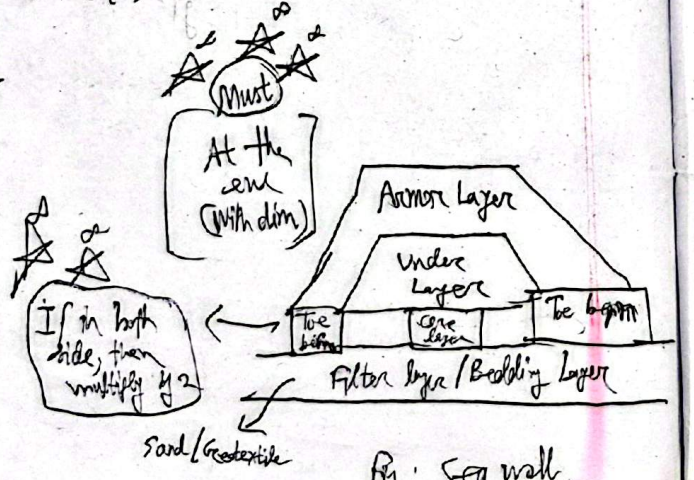


Fig: Sea wall

Sol^n:

(a) Armor Layer Design:

Weight of armor unit,

$$W_a = \frac{\gamma_a H^3}{K_D \left(\frac{\gamma_a}{\gamma_w} - 1\right)^3 \cot\phi} = \frac{2.65 \times (1.524)^3}{2 \times \left(\frac{2.65}{1.025} - 1\right)^3 \times 1.5} = 0.78467\ T = 785\ kg$$

Crest width of armor layer,

$$B = n k_\Delta \left(\frac{W_a}{\gamma_a}\right)^{1/3}$$

$= 3 \times 1 \times \left(\frac{0.785}{2.65}\right)^{1/3}$

$= 1.9998$ m.

n = number of stones

$= 3$

Thickness of armor layer,

$$t = n k_\Delta \left(\frac{W_a}{\gamma_a}\right)^{1/3}$$

where, $n = 2$.

$t = 2 \times 1 \times \left(\frac{0.785}{2.65}\right)^{1/3} = 1.3332$ m.

$$\frac{d}{gT^2} = \frac{2.524}{9.81 \times (7.468)^2} = 0.00461$$

$$\frac{H}{gT^2} = \frac{1.524}{9.81 \times (7.468)^2} = 0.00279$$

From graph we get,

$$\frac{\eta_c}{H} = 0.86$$

$\therefore \eta_c = 0.86 \times 1.524$

$= 1.31$ m.

Crest elevation $= (2.524 + 1.31)$ m

$= 3.834$ m.

(b) Under layer design:

Weight of under layer $= \frac{W_a}{10}$ to $\frac{W_a}{15}$

$= \frac{0.785}{10}$ to $\frac{0.785}{15}$

$= 0.0785$ T to 0.0523 T

Thickness of under layer = Depth of armor $= 1.3332$ m.

(c) Core layer design:

Weight of core layer $= \frac{W_a}{100}$ to $\frac{W_a}{400}$

$= 0.00785$ T to 0.00196 T.

(d) Toe beam design :

Weight of toe beam $= \frac{W_a}{10}$ to $\frac{W_a}{15} = 0.0785 T$ to $0.052 T$

width of toe beam $= 2H = (2 \times 1.524)\ m = 3.048\ m$.

Depth of toe beam $= 0.4\ d = (0.4 \times 2.524)\ m = 1.0096\ m$.

Depth of core layer = Depth of toe beam $= 1.0096\ m$

Structure height = Thickness of armor layer + Thickness of under layer + Depth of toe beam + Thickness of bedding layer

$= (1.3332 + 1.3332 + 1.0096 + 1.0096)\ m$

$= 4.6856\ m$.

Weight of structure = Wt of Armor unit + Wt of under layer + Wt of core layer + weight of toe beam

$= 0.94985\ T$.

Brief

[2-09-21]

* Math - All. & Derivation
* 24-25 ques.
* Failure mode, coastal structures' formula, Table (5-7) PDF.
* Harbor layout.
* Delta figs - All
* Coastal processes - Beach profile (fig)
* Bed load transport, Wash load.
* Spring tide, Neap tide - short Note.