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Study of Erosion of Egyptian Coast and Shore Line Changes

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Abstract:

In the last years erosion phenomena in the Egyptian coast have been increased dangerously. This phenomena has started after the construction of the High Dam in Aswan. The High Dam prevented the sediment load from reaching the northern coast that causes the unbalance between erosion and sedimentation. The northern Egyptian coast erosion has reached serious limits in the last years , approximately, 100 m per year.

The increasing of earth temperature and pools melting resulted in increasing of erosion phenomena in the northern Egyptian coast. Many cities and many resorts have been established along the north coast are exposed to serious dangerous from coast erosion. For this reasons this study have been occurred to understand it and to know its real size and to find the practical solution to solve this phenomena.

Introduction:

To understand Beach erosion first we must understand the erosion and sedimentation mechanism to cover all the reasons which cause these phenomena.

Many parameters effect on the erosion and sediment transport amounts of Beaches,
This parameter could be specific parameters such as sediment particles diameter, particles specific density, particles specific weight, water density, water specific weight, particle settling velocity, water dynamic viscosity and wave energy.

This parameter also includes local parameters such as the rising of sea levels and unbalance between sediments transports amount delivered from Nile River and the beach erosion amount.

This leads us to deduct the amount of beach erosion to find the suitable way to prevent it or to decrease it.
So this study have been achieved to understand this phenomena, this study divided into two main parts the first part is theoretical study includes approaches which define the sediment transport and erosion phenomena.

The second part is the practical solutions methods to overcome this problem which includes analytical deduction for the proposed method.

1- Theoretical Study:

1-1 Erosion and sediment transport mechanism:

1-1-1 Incipient Motion:

The beginning of particles movement needs a velocity to make bed particle starts to move according to (EL GOHARY. T) Approach which published in AL- Azhar civil engineering research magazine (CERM). Volume (28) No. (2) (2005) which stated that:

$$\mathbf{U_{cr}} = \sqrt{11.6 x g x r x Tan\phi r \frac{(\rho_s - \rho)}{\rho}} \quad \mathbf{.........(1)}$$

Where u_{cr} = particle critical Velocity (cm/sec),

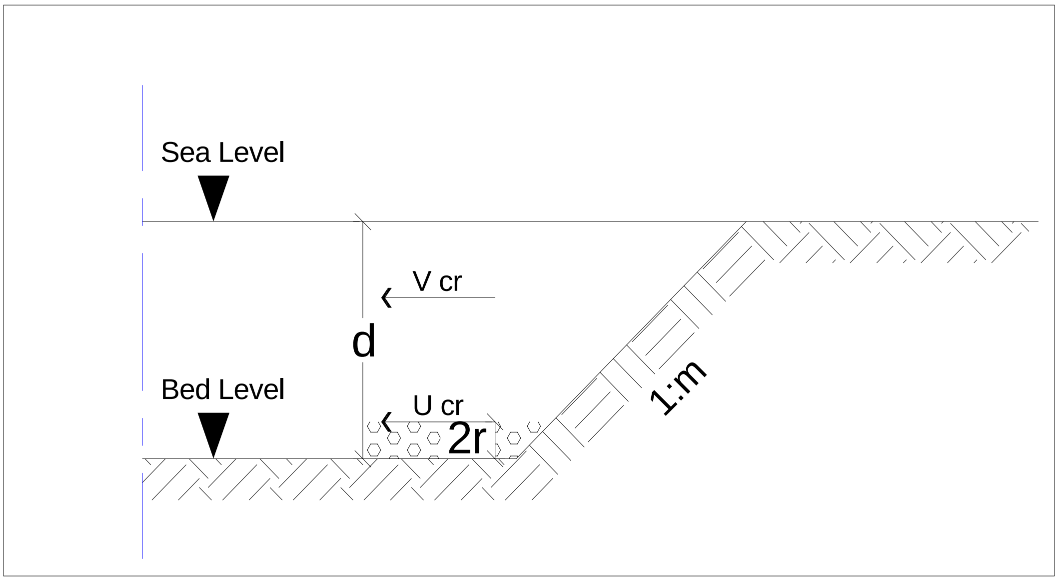
ϕ = internal angle of friction of soil (unit less),

r = particle radius (cm),

ρ_s = particle density (gm/cm^3),

ρ = sea water density (gm/cm^3),

g = gravity accele-ration (cm/sec^2).



Fig(1)

1-1-2 Erosion and sediment transport discharge:

The amount of beach erosion is equal to the amount of sediment transport discharge which divided into two main parts the bed load discharge and suspended load discharge.

1-1-2-1 Bed load transport:

The amount of beach erosion which contributes the amount of sediment transport discharge along the bed is called bed load discharge.

According to (EL GOHARY. T) Approach which published in AL Azhar civil engineering research magazine (CERM). Volume (28) No. (2) (2005) which stated that:

$$\mathbf{u} = \sqrt{32\frac{(\rho_s - 1)}{\rho} gr} \quad \text{.......} \quad (2)$$

$$Q_b = 2\ Ls\ u\ (\wp s - 1)\ r \quad \text{.......} \quad (3)$$

Where Q_b = bed sediment transport discharge for particular zone (cm^3/sec),

Ls = beach bed width (Zone of study) (cm),

$\wp_s$ = particle specific weight (gm/ sec^2. cm^2),

u = bed particle velocity (cm / sec),

r = bed particle radius (cm).

1-1-2-2 Suspended Load transport:

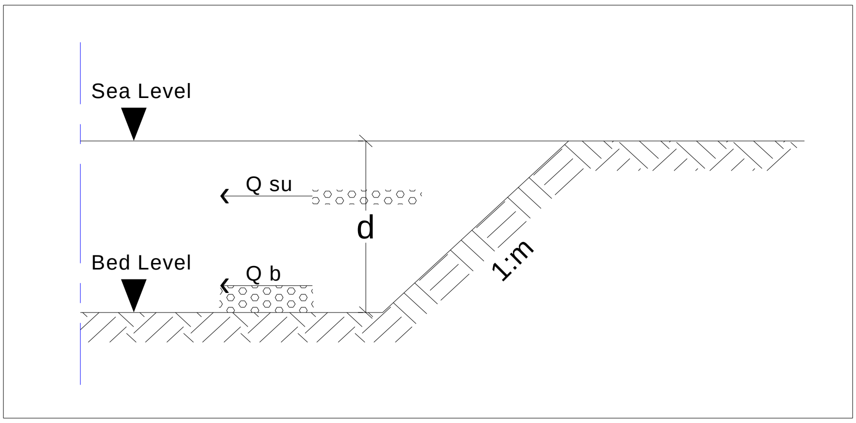
The amount of beach erosion which contribute the amount of sediment transport discharge suspended in the sea water coming from beach slopes is called suspended load discharge.

$Q_{su} = A \times Cr \times V$….. ………………………………………………………………………(4)

Where Q_{su} = suspended load discharge for particular zone (cm^3/sec),

Cr = concentration of sediment particles in sea water flow (gm/cm^3),

V = Flow Velocity (cm / sec).



Fig(2)

2- practical solutions for solving shore erosion problems:

2-1 Nourishment:

Replacing the erosion amount by another amount of sand out of the site As shown in fig(3) with condition that

$V_{erosion} = V_{Nourishment}$ ….. ……………………………………………………………..……(5)

$Q_{erosion}$ could be estimated from eq no (3) ,(4)

$V_{erosion}$ for one year per unit width of beach $= Q_{erosion} \times 365 \times 24 \times 60 \times 60$

$= 31536000 Q_{erosion} (cm^3) = 31.536 Q_{erosion} (m^3)$.......……(6)

$V_{Nourishment}$ = Volume of one year = V (m^3 / per unit width of beach)……… ....…………(7)

Where V = erosion volume / per unit width of beach (m^3) ,

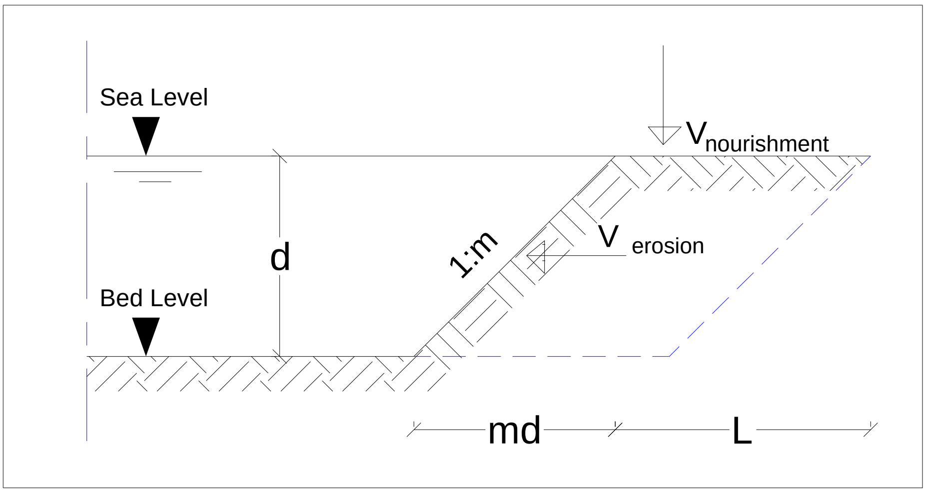
V = L d (m^3 /per unit width of beach) ....………………………………………...(8)

Where d = sea water depth near beach slope (m),

L =perpendicular bed eroded distance along one year (m).

Nourishment will decreases beach slope erosion and to decrease sea bed erosion near beach line we have to establish a gravel layer along the bed line.

As a result of the fact that critical velocity is a function of particle density and internal soil friction angle we well increase them by using a soil of higher density and higher internal soil friction angle such as gravel as mentioned in equation No (1). This will increase the limit of critical velocity which is needed to cause the bed movement.



Fig(3)

2-2 Shore protection:

In this method we will use R.C platform on beach slope directly anchored to the sea bed bottom by steel anchor of particular depth and tied by a steel tie road connected to R.C block.

Before erosion:

In order to get L' distance of the R.C platform we have to proposed it and check on slope stability for the beach slope as shown in fig(4) by the following eq

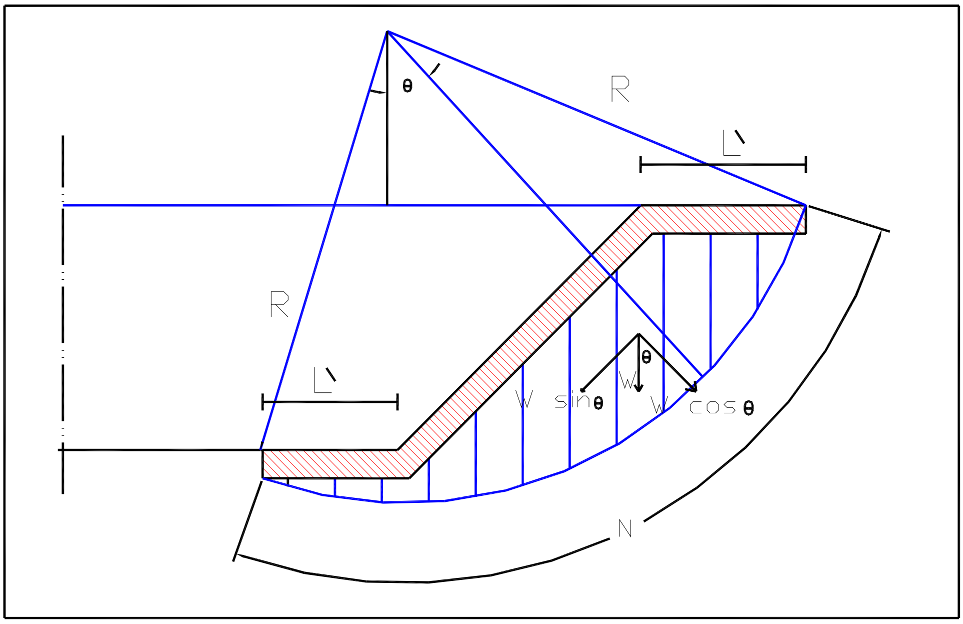
F.S against slope sliding = 1.5 = (NC+ tan ϕ Σ w cos Θ) / (Σ W sin Θ) ………………………...(9)

Where W = Total Load of wedge (Newton) = W soil + W platform,

R = Radius of rotation (m), N = length of soil wedge,

ϕ = internal angle of friction of soil, C = cohesion of soil.

That will increase L' or decrease due to slope stability.



Fig(4)

<u>After erosion:</u>

In order to get the tie member force and the anchor length calculate the moment about point 0 which is equal to zero at balance conditions as shown in fig(5).

e_1 =C + d $\wp$ sub Ka ..……………………………………...………………………....(10)

e_2 = C + (d + H) $\wp$ sub Ka...……………………………………...………………………....(11)

e_3 = H $\wp$ sub Kp…...……………………………………………...………………………....(12)

Where d = sea water depth (m),

H = steel anchor length (m),

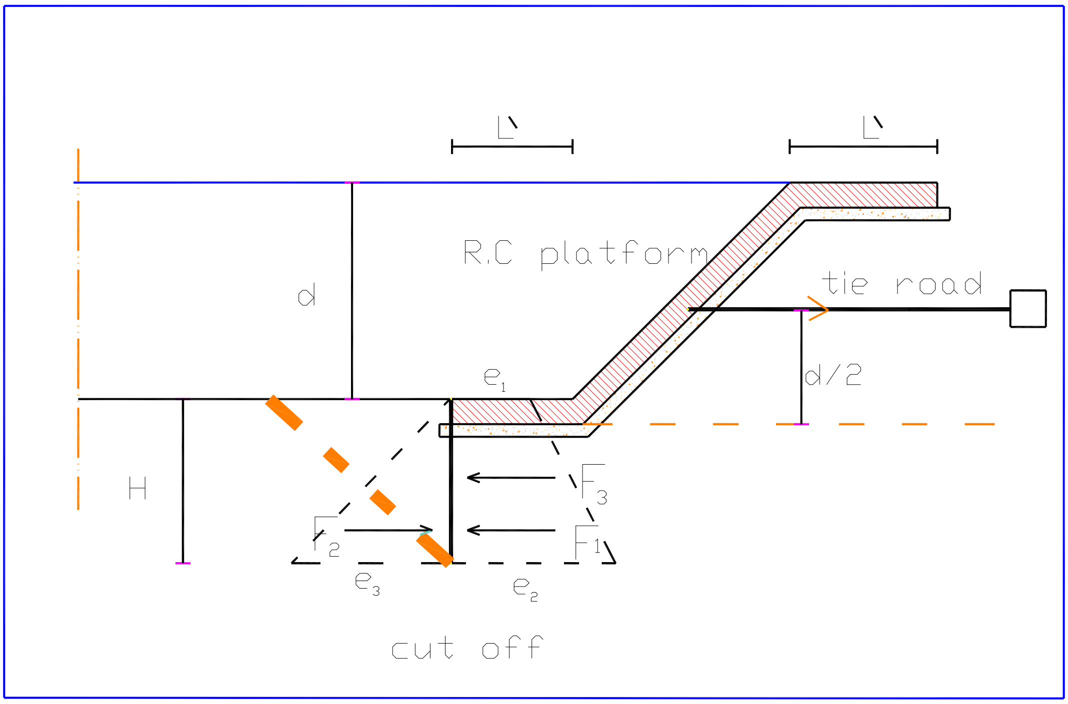
$\wp$ sub = submerged specific weight (Kg / sec^2 . cm^2),

Ka = active earth pressure factor

= (1 – sin ϕ) / (1 + sin ϕ),

Kp = passive earth pressure factor

= (1+ sin ϕ) / (1 - sin ϕ).



Fig(5)

<u>At balance condition:</u>

Moment about o = zero

Where T = tie member force

$\therefore$ F_2 x H/3 = F_3 x H/2 – T x d/2 + F_1 x H/3 ………………………...…………………….......(13)

$F_1 = (e_2 - e_1)$ x H/2

= (H^2 $\wp$ sub Ka)/2.. ………………………...……….…………………………........(14)

$F_3 = e_1$ x H = CH + d H $\wp$ sub Ka……………………..……………..………………………......(15)

$F_2 = e_3$ (H/2)

= (H^2 $\wp$ sub Kp) / 2……………………………………...………………………......(16)

$\therefore$ (H^3/6) $\wp$ sub Kp = (H^3/6) $\wp$ sub Ka – Td / 2 + CH^2 / 2 + dH^2 $\wp$ sub Ka / 2 …...………………......(17)

$\therefore$ H^3 ($\wp$ sub Kp - $\wp$ sub Ka) – $3H^2$ (C + d $\wp$ sub Ka) + 3 Td = 0 ……….……………………......(18)

at balance condition the sum of the horizontal forces equal zero

Σ horizontal Forces = 0 ……….……………………………………………………….…......(19)

$\therefore$ T + F_2 = F_1 + F_3 …………………………………… ………...……………......(20)

$\therefore$ T + H^2 $\wp$ sub Kp/ 2 = H^2 $\wp$ sub Ka / 2+ CH + d H $\wp$ sub Ka…………… …………………....(21)

$T = H^2/2$ (℘sub Ka - ℘sub Kp)……………………… …………… ……………………......(22)

ge (T) → (Ton / unit width of beach) and by replacing in eq(18)

∴ H^3 (℘sub Kp - ℘sub Ka) – 3 H^2(C + d ℘sub Ka) + 3d $H^{2(}$ ℘sub Kp- ℘sub Ka) / 2

+ 3d H (C +d ℘sub Ka) = 0 ..……………………… …………… ……………………......(23)

∴ H^2 (℘sub Kp - ℘sub Ka) –3H(C + d ℘sub Ka/ 2 + d ℘sub Kp/ 2)+ 3d (C +d ℘sub Ka) = 0 …………………………………………………………………………………………...(24)

From the previous equation is from 2nd degree we could get anchor length (H) value and we will take the positive value , This value will be multiplied by 1.5 for factor of safety. This value must be greater than the predicted eroded beach bed depth for a period of 50 years.

Conclusions:-

1- Share Protection for share slope could be by using nourishment method to decrease side slope erosion by Replacing slope erosion amount by another imported amount by using equation No (8) to decide the needed volume for one year after knowing the predicted shore erosion perpendicular distance at the same period.

2- Shore protection for bed bottom near share line by using another soil type of higher density and higher internal friction angle such as gravel to increase the incipient motion limit for bed particles.

3- Shore protection for shore slopes could be by establishing R. C plat form directly on the beach slope provided with vertical anchored steel plate it's length could be estimated from equation No (24) and provided also with horizontal steel tie road and it's section could be estimated by knowing it's force by using equation No (22).

Recommendations:-

1- Using unusual different methods for shore protection and for decreasing shore erosion should be studied.

2- Suggesting a system for the case of rising of sea level to avoid it's destructive effect on urban areas near beaches should be studied.

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