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INVENTION OF FLOATING GATES BASED ON ARTIFICIAL INTELLIGENCE DESIGING FOR MARED DAM AND WATERWAY, KARUN RIVER

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The Karun River is oriented from Zagros Mountains. In the MARED pump station, flat dam and waterway should be constructed to prohibit the intrusion of Persian Gulf tide waves. First layout belonged to SWECO consulting engineering in 1975 that were decided to build ship lock and dam by cubic concrete boxes as the main structure. Dam bed should be stabled to pass barges through waterway (500tons capacity) and concrete piles ($30¸000¸000 in 2010). Second scheme of dam and waterway were designed to make with steel pipe piles, steel gates, concrete walls and embankment at 2018 more than $100¸000¸000 cost. Invention design could be replaced in the MARED dam and waterway. Floating steel gates must be rotated vertically by AI Designing. Steel gates shall be designed to addition air inside the gate body. Movable gates are simulated through the fish swim bladder to operate the system that can be adapt with the water fluctuation. Air could be inserted into the simulated swim bladder by the compressor to buoyance the gates. Also, it can be discharge the air automatically when the water level needs to be down. The effective depth is more than +18m therefore floating gates should be made by the hollow steel box. The total cost of the third scenarios may estimate less than $10¸000¸000 for AID at 2023. Main dam will be made to reduce costs using the pipes piles and buoyancy gates. Sediment flow can be pass easily through the dam bottom and monitoring floating gates.

Keywords: Swim Bladder, Sediment Flow, Flat Dam, Monitoring, Cost, Pipe piles.

1 INTRODUCTION TO MARED DAM AND WATERWAY

MARED pump station is located near the Karun River, NW of the Persian Gulf region with capacity 120m^3/sec. MARED Dam was designed to control the sea water intrusion by the SWECO consulting engineering in 1975 for project of irrigation and drainages of Abadan Island and Khorramshahr (Turk 2001, 2003). It must be increase the water level to control the normal operation of pump station in the low discharge conditions. MARED Dam will be constructed near the pump station to decrease the cost of embankments.

2 SCENARIOS EXPLANATION

2.1 First Scenarios of SWECO 1975

The Karun River bed must be stable by pile driving to install hollow precast concrete boxes as the body of the dam, Figure 1. Concrete boxes can be dropped from ships onto the river bed. Boxes are arranged in rows like the Egyptian pyramids. This work will execute from bed to above the water level. The important stage was the leveling of the concrete pile cap in the river bed. Concrete boxes are filled with sand to make them stronger and heavier (Turk 2003, 2004a, 2004b, 2005 and 2006a).

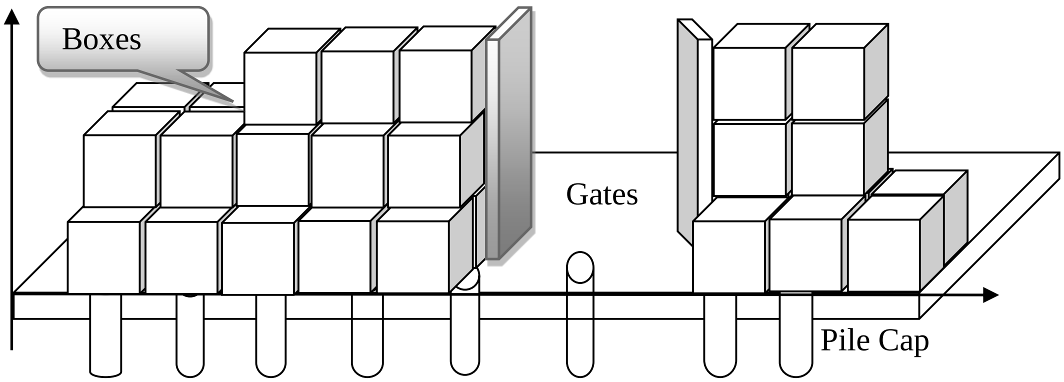

Figure 1. SWECO design can demonstrate the arrangement boxes, Cast-in-place piles and pile cap in the Karun River Bed. Boxes must be floated to submerging in the water (Beer 2012).

2.2 Second Scenarios – Steel Piles, Concrete Walls and Embankment 2018

The river bed of Karun must be stable by pile driving to install a hollow precast concrete box as the body of the dam. Figure 2 shows the Concrete boxes that will be submerged to drop slowly in the water. Finally, it should be settle over the pile cap by ship and crane in gradually moving.

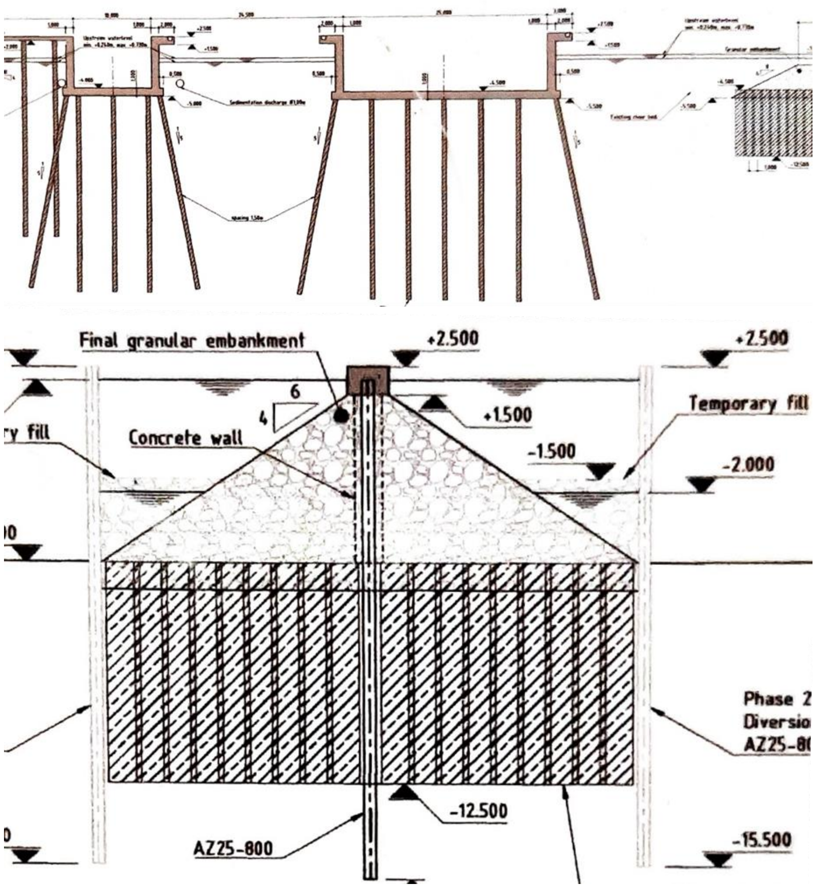

Figure 2. Driving piles and concrete walls will present the erroneous embankment design (Chellis 1951).

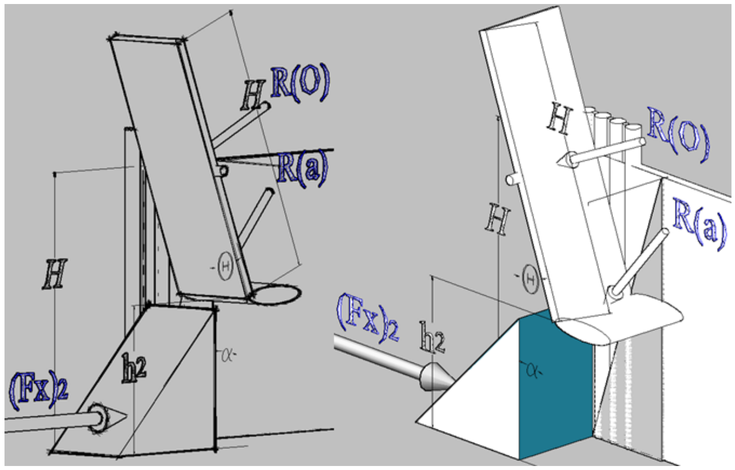

Figure 3. Innovation AID shows in front and sides views. Floating parts are variable respect to water level in floods and drought years. $F(X)_1$ and $F(x)_2$ were estimated by Momentum Equations.

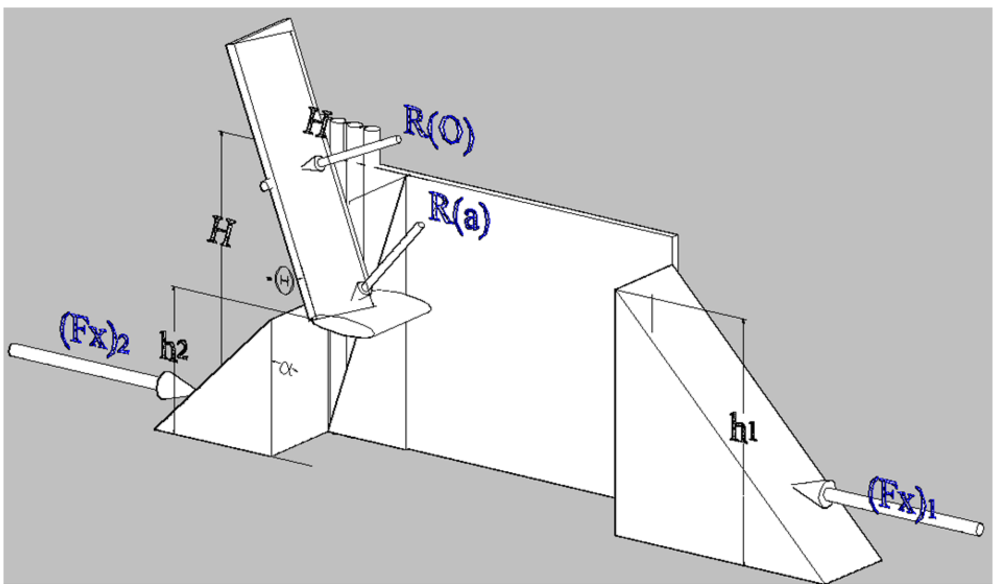

Figure 4. Free diagram may demonstrate by $F(X)_1$, $F(X)_2$ and reactions R (a) and R (O), (Turk 2008).

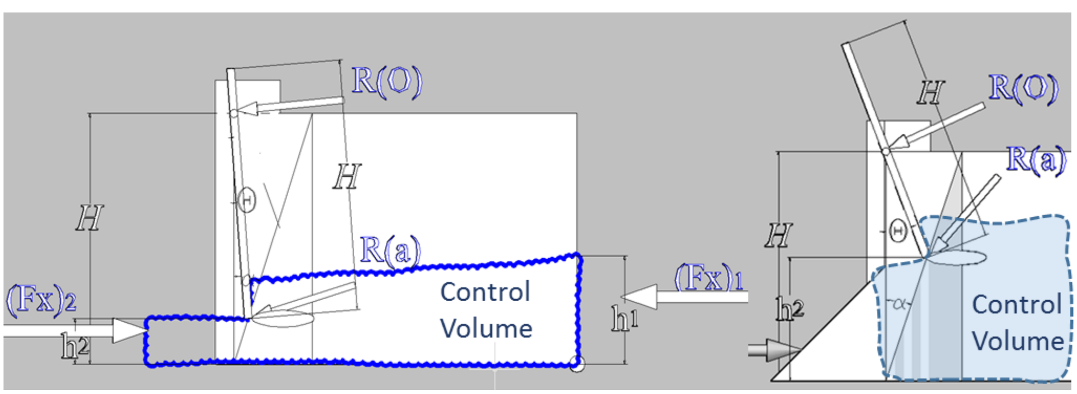

Figure 5. The Q_{out} is denoted by h_2 and Q_{in} mentioned by h_1 (Turk 2006b, Turk 2009a. Turk 2009b).

2.3 Floating Steel Gates AID

Serious problems could be damaged the dams such as sedimentation flows and insufficient studies. Dams will be unused to utilize in the hydrology system and downstream when the reservoir capacity fills through sediment and soils. If the hydraulic flow path of the river is the same as before the construction of the dam, no sediment will be trapped behind the dam. Figure 3, Figure 4 and Figure 5 demonstrate the AID of variable gates and floating members. In these Figures, flow is passing through the bed of the hydraulic system to increase the life time and useful services. Gate with length H can rotate and move around the constant horizontal pin. Also, floating gate must move on the slipping line with angle values of α◦ from 7 to 12 degrees. Slotting lines can be converted into parabolic curves if expert engineers can perform complex steel plates in the workshop (Turk 2017).

3 MOMENTUM EQUATIONS FOR FLOATING GATES BASED ON BED CURRENT

It is supposed that Q_{min} (120 m^3/sec) can be fixed to operate MARED pump station. The maximum flow will be Q_{max} (3¸000 m^3/sec) and the minimum current may be less than Q (100 m^3/sec). Control Volume (CV) and Control Surface (CS) are determined through the 5m width and 100m length in River direction from h_1 to h_2. The Karun River dimensions were measured at the mentioned position with the Width (W = 250m) and the depth (15m). Eq. (1) to Eq. (13) are used to compute the forces and reactions, such as F(X) $_1$, F(X) $_2$, R (O) and R (a), (White 2017).

$$\frac{d}{dt}(mV)_{syst} = \sum F = \frac{d}{dt}\left(\underbrace{\int V\rho dv}_{CV}\right) + \left(\underbrace{\int V\rho(V_r \cdot n)\cdot dA}_{CS}\right) \tag{1}$$

$$\sum F(X) = \frac{d}{dt}\left(\underbrace{\int V\rho dv}_{CV}\right) + \sum(\dot{m}_i V_i)_{out} - \sum(\dot{m}_i V_i)_{in} \tag{2}$$

$$\underbrace{\int(r\times V)\rho(V.n)dA}_{CS} = \sum(r\times V)_{Out}\cdot\ \dot{m}_{out}\ \text{-}\sum(r\times V)_{in}\cdot\ \dot{m}_{in} \tag{3}$$

$$R_x(a) + R_x(O) = +\frac{1}{2}Z\rho g h_1^2\left(1-\left(\frac{h_2}{h_1}\right)^2\right) - \rho h_1 V_1^2 Z\left(\frac{h_1}{h_2}-1\right) \tag{4}$$

$$R_X(O) = {R_y(O)}\Big/{tg(\theta)} \tag{5}$$

$$\sum F_Y = R_Y(a) + R_Y(O) + F_{Bi} + F_{Bii} - W_i - W_{ii} = \frac{d(v_Y)}{dt}(m_i + m_{ii}) = a_Y\cdot\sum_{i=1} m_i \tag{6}$$

$$V_2 = \frac{h_1}{h_2}V_1\,,\ \ F_{Bi}\ \geq\ \ W_i \tag{7}$$

$$tg(\theta) = \frac{h_2}{H-h_2}tg(\propto),\ \ \Delta x = \left(H - h_2\right)\left(tg(\theta) + \frac{1}{tg(\theta)}\right) \tag{8}$$

$$\sum M_I = \frac{\partial}{\partial t}\left(\underbrace{\int(r\times V)\rho dv}_{CV}\right) + \underbrace{\int(r\times V)\rho(v.n)dA}_{CS} \tag{9}$$

$$\underbrace{\int (r \times v)\rho(v.n)dA}_{CS} = \sum (r \times V)_{Out} \cdot \dot{m}_{out} - \sum (r \times V)_{in} \cdot \dot{m}_{in} \tag{10}$$

$$Ry(a) = \left[\frac{1}{2}\rho Z(h_2V_2)^2\left(1-\left(\frac{h_1V_1}{h_2V_2}\right)^2\right) - \frac{1}{2}\rho g Z {h_1}^2 h_2\left(1-\frac{h_1}{3h_2}\right) + \frac{1}{3}\rho g Z {h_2}^3\right] / \Delta x \tag{11}$$

$$R_X(O) = \frac{R_y(O)}{tg(\theta)}, \quad \Delta h = h_1 - h_2 \tag{12}$$

$$R_y(O) = Wii\left(1 - \frac{\Delta h}{HCos(\theta)}\right) + R_y(a) \tag{13}$$

3.1 Parameters Definition

Parameters will defined by Q_{in} (m^3/sec) inlet discharge of the Karun River (+100, +250, …. 3¸000), Q_{out} (m^3/sec) outlet discharge into downstream that may be vice versus from the Persian Gulf intrusion (±0.0, +100, +200, +3¸00), h_1 (m) height of water level at inlet (1, 5, 10, 12, 15), h_2 (m) height of water level at outlet (+1, +5, +10, +12), H (m) height of dam from bed to crown (15m), Z width of the CV (5m), angle values α˚ from 7 to 12 degrees, angle θ is variable (0˚, 5˚, 10˚, 15˚, 30˚, 45˚, 80˚ and 90˚). Figure R (a) is the reaction force at connection (a), also, figure R (O) is the reaction at joint (O) that is exerted on the pin through the 90◦ direction. It will be perpendicular all time on the gate surface when the gate rotates or moves around the pin axes. Specific gravity of water denotes by the figure γ (1.0 ton/m^3). Eq. (1) to Eq. (3), Eq. (9), Eq. (10) and Figure 6 will interpret the momentum fundamental relation that will use to compute $\sum F_X$, $\sum F_Y$ and $\sum M_I$. The index (I) in $\sum M_I$ is the intersection lines of R (a) direction and h_2 water level in the node (I). In Figure 3 to Figure 5, Eq. (6), Eq. (7) and Eq. (13) parameters W_i and F_{Bi} are refer to weight and buoyancy forces of ellipsoid floating part, (White 2011). Figures W_{ii} and F_{Bii} are the weight and buoyancy forces of floating gate. In Eq. (4), Eq. (9), Eq. (10) and Eq. (11) figures v_1 and v_2 are the velocity in inlet and outlet. In Figure 6 Δh should be determined to desire Eq. (11) and Eq. (12).

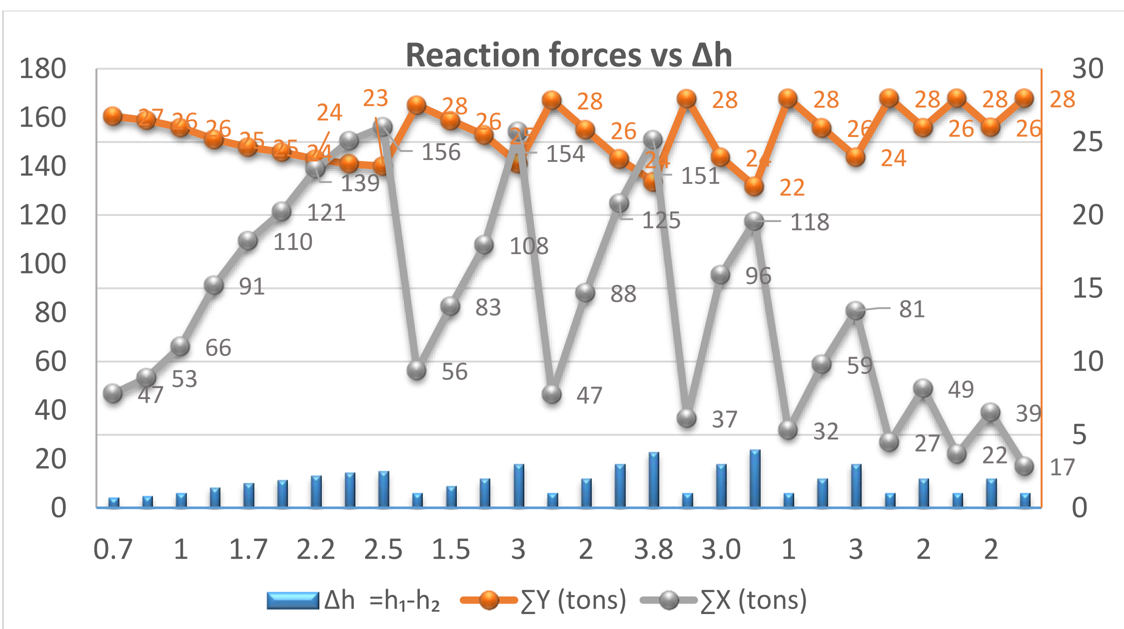

Figure 6. Forces ∑X and ∑Y are increased by h_1 (8 ~14m) and corresponding to the Δh (2~ 4m) in CV.

3.2 Swim Bladder Simulation –SBS- for Floating Part

Floating part should be enable to rising and submerging in the water when the water level behind the gate will fluctuates suddenly by flood. A thick plastic air bag is embedded into the floating part to connect to the air compressor which works automatically. In future SBS, maneuverability of the invented model will be control in the laboratory. Ellipsoid section in Figure 3 will be a SBS part.

4 ECONOMIC ASPECTS

Table 1 shows a clear comparison for the three scenarios that provide the appropriate decision for the government. The increase in ratio (%) can be reduced to achieve lower cost by Invention AID.

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Scenarios	Year	COST ($)	+Ratio (%)	Advantageous	difficulties
SWECO 1975	2010	30,000,000	+300	Simple Working	Annual Sedimentation
Concrete Walls	2018	100,000,000	+1,000	Mistake Design	Sedimentation
Invention AID	2023	10,000,000	1	No Sediment by Bed Flow	Need Expert Workers

5 CONCLUSION

It is mentioned that the SWECO1975 design was changed by KWPA technical office into concrete walls and piles at 2018. AID is the only solution to reduce costs and dragging. Sedimentary flow could be passed through the river bed by the Invention of maneuverable gates. Stable wall will be made by driving steel pipe piles, ellipsoid floating and slotting parts, Figure 3 to Figure 5.

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