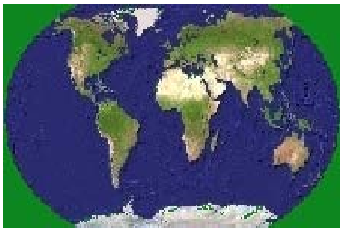
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Design of Check Dam for Effective Utilization of the Aflaj Water Resources

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Abstract
The Sultanate of Oman, the Middle East country has limited water resources. Ground water and surface water are limited and confined to some areas. To ensure water security for agriculture purpose, construction of Check Dams is the best option. At present the Aflaj, a natural stream which originates from Oman Mountains, is meeting agriculture and drinking water needs of rural Oman people. (Rajib Chakraborthy, 2012) The Aflaj contains five channels by name Falaj Daris, Falaj-Al-Khatmeen, Falaj-Al-Malki, Falaj-Al-Muyassar and Falaj –Al-Jeela. The Falaj Daris water is soft with electrical conductivity 477 microchips/cm and with pH 7.3[1].The Falaj Daris channel has two branches of length 1.7 kilometers and 1.9 kilometers. The average flow is 2 cubic meters per second. The Falaj Daris, which is of Daudi Aflaj type is as shown in Fig: 1.The check dam location is selected at Willayat Nizwa keeping in view of its slope and proximity to Falaj Daris. During rainy season the water is stored in the check dam and released in to the Falaj Daris as and when required. The main objective of this Check Dam design is to collect the rain water and to connect the Check Dam to Falaj Daris so that the water can be distributed through Falaj Daris channel. In this design an attempt is being made to reduce evapotransmission losses

Keywords: Agriculture, Check Dam, Falaj Daris, Reservoir, Willayat Nizwa

1. Introduction

The world is facing acute shortage of safe drinking water. There is a need to collect each and every drop of rain water from all possible ways. The best options are rainwater harvesting from roof tops, collection of storm water runoff and catchment yield from catchment area. The terrain of Oman is hilly, rocky and sloppy. These are the best suitable conditions to collect the rain water. There is ample opportunity to construct Check dams wherever possible. In Oman the average annual rainfall is 100mm. The check dam is designed where slope is more predominant. The check dam works like a storage reservoir. Particularly during monsoon season storm water can be stored in the check dam. Monsoon precipitation occurs between December and April, part of it go for deep percolation and evaporation (very high) and the remaining as a runoff and may end up to the sea. In order to maximize the use of the scarce water resource a check dam was proposed.

Willayat Nizwa is an ideal place to construct Check Dam on Falaj Daris. This area experiences rain fall twice in a year, during summer due to south-east monsoon and during winter due to north-east monsoon. (Niels Shtz, 2012) The Falaj Daris have two channels and forms like a "Y" junction. The meshed area in fig.2 is the identified area for check dam. This Y junction is best suitable for Check Dam.

The Aflaj is the main water resource for drinking as well as for agriculture purpose in rural Oman. More than one third of irrigation water is supplied by *aflaj* (singular: *falaj*), which provide 680 × 10^6 m3 of water per year and irrigate some 26,500 ha.(Ref.5). Due to population growth, the 2000 years old Aflaj is unable to meet drinking water needs of rural people.(Abdullah Al-Ghafri et.al 2004). To augment the flow of the Aflaj water, certain places are being identified to construct check dams. These check dams' releases water in to Aflaj in a controlled manner, so that the flow of Aflaj will continue throughout the year. One of the best suitable places to construct check dams is at Nizwa on Falaj Daris. Two channels of Falaj Daris are forming a "Y" junction at Nizwa. Moreover the area has a good slope to collect rain water.

The factors affecting catchment yield are catchment area, soil texture, slope and rainfall. Geo technical studies like soil permeability, load bearing capacity of soil, water holding capacity, and foundation depth and foundation material were studied.

The flow of catchment area is measured using the formula,

$$Q = 0.278\ C\ I\ A \quad \frac{m3}{s}$$

The quantity (Q) of storm water runoff can be calculated using the below formula.
Where C= Runoff coefficient (0.22)
I = Average rainfall (mm/hr.)
A = Area of catchment basin (km^2)

Since the average annual rainfall in Oman is constant, the quantity Q can be increased by increasing the catchment area "A" in km^2.

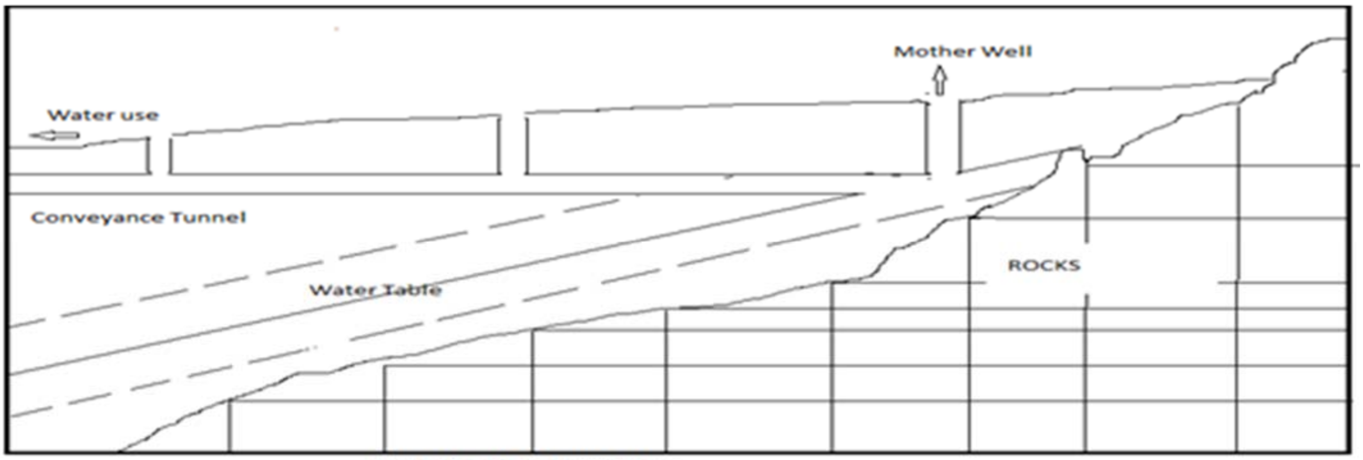

Fig: 1 The Aflaj Flow System

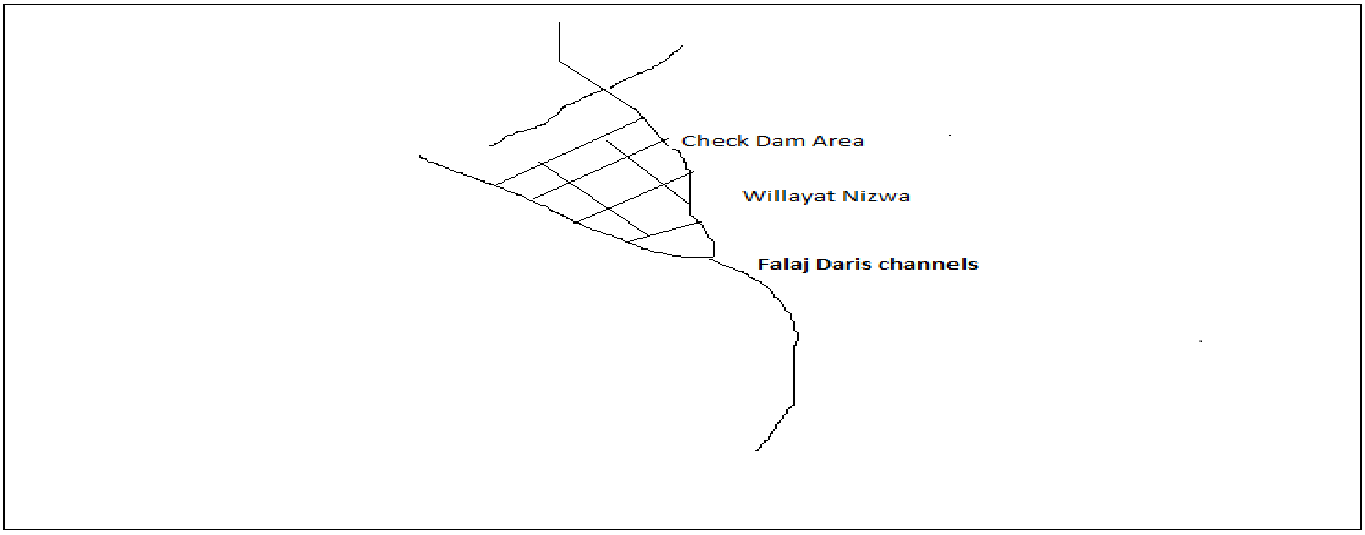

Fig: 2 : Check Dam Area and Location.

Literature review

Abdullah- Al –Ghafri, et.al, 2004 "Irrigation Scheduling of Aflaj of Oman. Methods and Modernization, Journal of Scientific Research, 2004, pp. 404-407.

In this paper the authors discussed about the traditional methods of irrigation in Oman using Aflaj water. The Aflaj water is being distributed to the farmers by the Wakil. The Wakil used to fix the quantity of Aflaj and the time to the farmers. In this paper the authors suggested modern methods of irrigation for effective utilization of Aflaj water.

Niels Shutze et.al,2012 " Optimal Planning and Operation of Irrigation Systems under Water Resource Constraints in Oman considering Climatic Uncertainty" Springer, Journal of Environmental Earth Sciences, March,2012,vol 65, 5 pp 1511-1521.

In this paper, the authors introduced four types of stochastic framework for decision making for optimal planning and operation of water supply for irrigation. They are

1. A weather generator for simulating regional impacts of climate change.
2. A tailor-made evolutionary optimization algorithm for optimal irrigation.
3. A mechanistic model for simulating water transport and crop growth
4. A kernel density estimator for estimating stochastic productivity, profit and demand functions by a nonparametric method.

In addition, microeconomic impacts of climate change and the vulnerability of the agro-ecological systems are discussed.

Rajib Chakraborthy, Centuries Old Aflaj Irrigation System in Oman, Proceedings of the ICE-Engineering History and Heritage, Volume 165, Issue 01, May, 2012 pp 73-80. In this paper the author outlined how the water table near mountains is tapped and channeled for irrigation and drinking water purpose. He concluded that Aflaj, which is 2500 years old as one of the world heritage site.

The Study area

The study area Willayat Nizwa is located at underneath the foothill of Al –Jeebal and Al-Akhadar hills. The Falaj Darris source is located at 25.4349^0N and 55.6315^0 E coordinates in Dakhilyah region of Oman. Willayat Nizwa consists of Falaj Daris channels of and its distribution system. The study area is shown in figure 3.

Fig:3 .Study Area

Geological Information:
The area consists of both alluvial soil and sandy soils. Agriculture is being practiced in alluvial soil area. Hill area consists of sandy soil.
Geotechnical Information:
Shallow test pits up to 1.5 m depth dug to study the geotechnical profile of soil (table 1). Check dam does not require detailed geotechnical information.

Depth (cm)	Description
0 (Ground surface)	Top soil, black organic, fragments of different rock sizes, Clayey Silt.
0-25	Dark brown, moist Silty Clay with traces of rock pebbles.
25-50	Gray, moist Clayey Silt with a trace of rock fragments.
50-75	Brown, wet medium Silty Sand
75-100	Clayey Silt with a trace of rock fragments
100-150	Same as previous sample.

Table (1), typical drilling log of a soil boring in check dam site

Design

Location of Site: The check dam is designed keeping in view of its effective drainage area (catchment area) and slope. The location is far away from residential area and does not contain any agricultural land.

Seepage Control: The reservoir area is to be excavated using proclaimer's up to a depth of 0.6m and leveled using 50mm gravels. The entire reservoir bottom floor is lined with two layers of 5 mm HDPE sheets.

Structure of Check Dam: The reservoir is devided in to three compartments with different heights. The purpose of multi-storage compartments is for removing most of suspended sediments from water before entering feeding canal.
In – situ concrete foundation and rock-cement abutment is preferred to increase the life of the check dam. The structure of check dam is as shown in fig 4. Gates are provided in each compartment to discharge the water in to falaj daris. The reservoir is fitted with HDPE pipes of 12.5 cm diameter with valves to distribute the excess water to nearby villages.

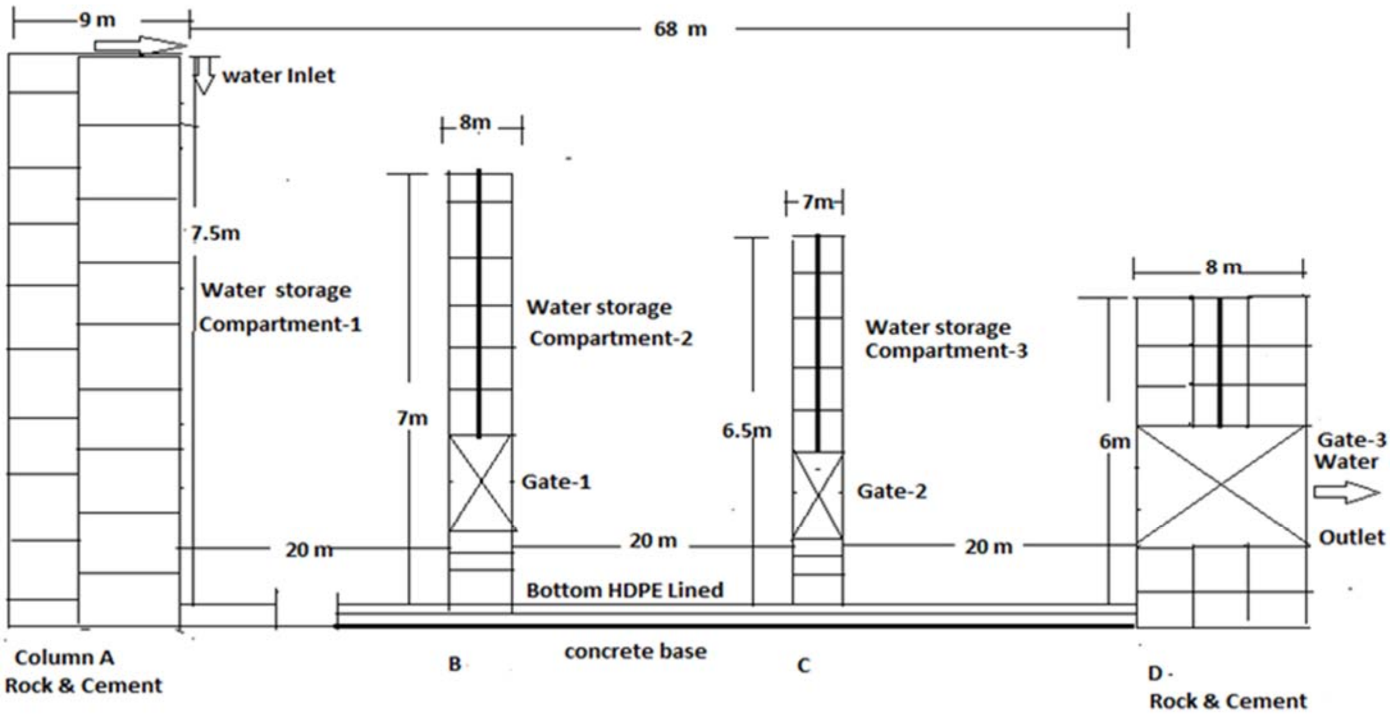

Fig 4: Check Dam : Not to Scale

The Foundation: The depth of the foundation columns A, B, C and D are 1.5m. Above the ground level the abutment A thickness is fixed at 9 m with rocks and cement. The height at A is fixed at 7.5m and width is 15 m. A concrete bottom is made with 60mm thickness. The concrete bottom is lined with two layers of 5 mm HDPE sheets each. The gates dimensions are 1m x 0.5m and made with 25 mm thickness hardwood.

The length of each compartment is fixed at 20 m. The heights of compartments 1, 2 and 3 are 7.0m, 6.5m and 6.0m respectively.

The storage capacity of compartment-1 is 20 x 50 x 7 = 7000 m^3

The storage capacity of compartment -2 is 20 x 50 x 6.5 = 6,500 m^3

The storage capacity of compartment -3 is 20 x 50 x 6 = 6,000 m^3

The total storage capacity of check dam is = 19,500 m^3

The bottom floor area of check dam 3000 m^2 (60 m x 50 m) is meshed with 6mm steel rods with a depth of 60mm covered with M-30 grade concrete.

The equation is a good (although not perfect) estimator for the probable flow in a channel at a given depth and slope. It can be used for estimating the flow in storm water channels for erosion and sedimentation control plans, for sizing gutters and spacing inlets in a storm water collection system or for sizing sewer or storm water pipes. The details of check dam floor and foundation is shown in Fig:5.

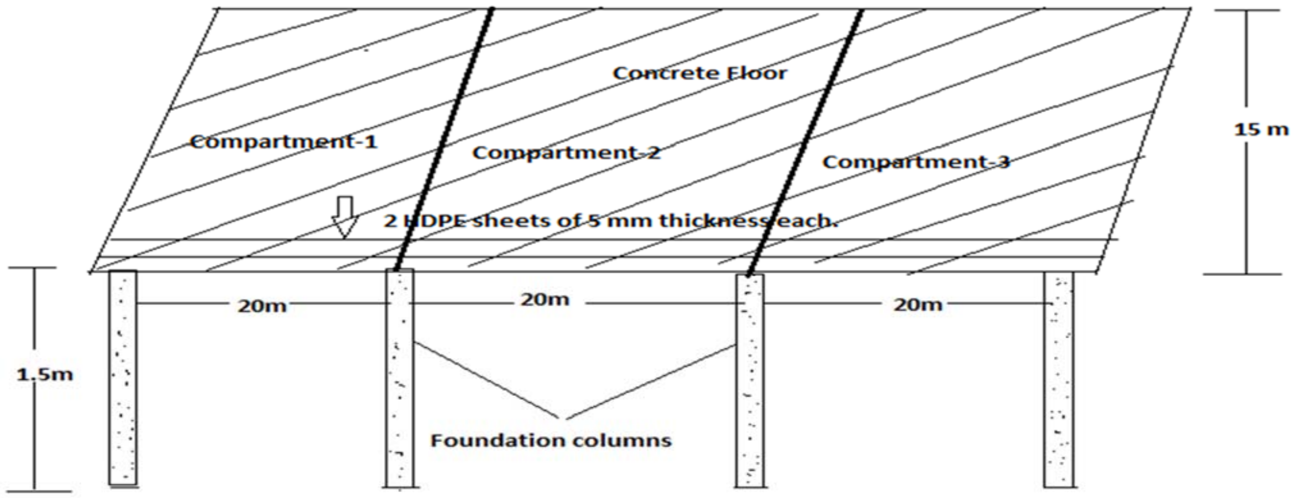

Fig 5 : Check dam floor and foundation

Factor of Safety F.S is given by(Ref2)

$$F.S = \frac{ic}{i} = \frac{Hc/Db}{H/Db} = \frac{Db(\gamma m - \gamma w)}{H\gamma w}$$

Where ic = Critical gradient

i = Design gradient

H = Upper head at downstream toe measured above tail water

H_c = Critical uplift

D_b = the thickness of the top impervious blanket

γ_m = Estimated saturated unit weight of the material in the top impervious blanket

γ_w = the unit weight of water.

(Source: Guidelines for safety inspections of Dams, Government of India, Ministry of Water Resources)

Conclusions

The Check dam converts dry lands in to green fertile lands. The Check dam can irrigate 38 hectares of land per day and can supply drinking water to 1,100 people per day at a rate of 150 liters per head. It contributes for economic development of rural Oman. The stored Water at the check will be used to augment Falaj Daris canal or to supply nearby villages water for irrigation. Check dam can also be used for recharging ground water.

References

1 Abdullah- Al –Ghafri, et.al, 2004 “Irrigation Scheduling of Aflaj of Oman. Methods and Modernization, Journal of Scientific Research, 2004, pp. 404-407.

2 Guidelines for Safety Inspection of Dams, Government of India, Ministry of Water Resources

3 Niels Shutze et.al,2012 “ Optimal Planning and Operation of Irrigation Systems under Water Resource Constraints in Oman considering Climatic Uncertainty” Springer, Journal of Environmental Earth Sciences, March,2012,vol 65, 5 pp. 1511-1521.

4 Rajib Chakraborthy, Centuries Old Aflaj Irrigation System in Oman, Proceedings of the ICE-Engineering History and Heritage, Volume 165, Issue 01, May, 2012 pp. 73-80.

5 Saif Al Amri, et.al, 2014 "Water Management of *Falaj* Al Khatmain in Sultanate of Oman"