Research paper On Soil Water Conservation.

ICT tool application for Soil Water Conservation Structures Design

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Abstract: This issue includes article that takes over various methods and topics related to soil and water conservation, irrigation in the agriculture sector. This includes the various methods of building proper architectural infrastructure that provides the farmers to conserve water from evaporating and also from sipping into the soil. A firm analysis of soil texture, type, chemical properties, roughness and the drain properties are being calculated from over last5 years in Konkan region. This Proposed system would be a standalone application, or it would be a website, Android app too. Various e-Agriculture Related apps and websites are present but the system that is related to Konkan region is not yet present. The proper use of soil and water is must to ensure the future of our surroundings and out future Generations

This proposed system gives you the opportunity to test the soil properties and suggests you the proper infrastructure (Nala , Damns , Bridges, canals) . Depending upon the river, water source the system would decide which structure is appropriate for the desired location. The Soil bulk density and pH would be evacuated in this system. Rainfall and weather prediction would be also included in this system.

Key word: -Agriculture,e-Agriculture,apps,website

I. INTRODUCTION

Konkan region receives an average annual rainfall of 3500 millimeter. Still the region faces the water scarcity in the non-monsoon seasons. Due to hilly terrain most of rainwater goes quickly as the surface runoff and also causes severe soil erosion. Hence it is essential to harvest the rainwater.

Water harvesting refers to the act of runoff water storage in ponds for off-season use. Water harvesting can be achieved by construction of structures like farm ponds, small check dams, nala bunds, gully plugging, percolation tanks etc. These structures are integral part of the soil and water conservation activity and are important components of the watershed development and management programme. Nala bunds either made up of earthen material or cement masonry. It stores the water increase percolation improves soil moisture regimes and regulates flood water. Competent civil and agro-engineering techniques need to be used in the design, layout and construction of permanent check dams to ensure proper storage and adequate outflow of surplus water to avoid scours on the downstream side for long-term stability of the dam. It is therefore essential to make survey and study the geo-morphology of watershed for planning, designing and execution the work of soil and water conservation structures. The water harvesting structures need to be tested for hydrologic, hydraulic and structural design before their execution so as to ensure their safety as well as their functional efficiency.

In the state of Maharashtra, nala bunding works are being carried out since 1969. The soil and water management activities in the state are being carried out in integrated manner on watershed basis since 1983. Nala bunding is one of the important activities of the comprehensive watershed development programme in the state.

The Department of Agriculture, Government of Maharashtra has constructed earthen and cement structures commonly called as Nala bunds, in order to harvest surface runoff under various soil and water conservation programmes. Present study is undertaken to study and compare the design of cement nala constructed by the Department of Agriculture with the standard design. A cement nala bandh in the agricultural watershed of shivnari, Dapoli tahsil will be selected for evaluation with, the following objectives;

1) To design the cement nala bund by following standard design procedure for the site in Shivnari watershed

2) To compare the design parameters of existing cement nala bund with standard design.

Soil is the most essential source and need of food, protein fiber and shelter to us humans. Basically all the life in soil is perceived as something important. Soil plays an important role in day to day life as well as water too. During Rainy season the quality of the soil gets down to lack of important factors present in the soil. This proposed system allows the farmers and other villagers to maintain the soil quality and the level of the water above the ground and below the ground too. This proposed system helps to find out the best infrastructure for the need of conservation of water and soil based on the geographical analysis bass civil defense geographical and civil infrastructures that depending upon a wide range of soil type the soil covering the Earth surface takes many years to develop but the quality of the soil should be maintained. Sometimes to increase the amount of potassium in the soil the soiled has to be. Burnt but due to search manmade activities the quality of the soil gets degraded. Now going to the water conservation part we should not let the water operate so we should build some sort of infrastructure that helps us to analyse soil type texture chemical properties and the dream properties of the soil and the water in Maharashtra various types of soils are found mainly red soil black soil and the Texas soiled that includes rocks table stand

Soil erosion

In agriculture soil erosion is also known as the removal of the top layer of the soil by man made calamities or natural calamities what are the forces searches water wind air although these forces are associated with the farming activities in the village. The concept of erosion reviews the nutrient rich layer from the soil and its lost the potential of the soil to sustain the nutrients that provides the plant is being reduced. Without the water the soil becomes a land just like a desert that is unable to support life form thus we can say soil erosion is a naturally occurring process that affect all landforms and all and types. Soil erosion can be classified in mainly two types number 1. Accelerated and II geographical erosion

Water erosion

Globally we found CVR types of water erosion and soil erosion basically the detachment of soil particles from its original place due to the movement of water is called as water erosion first leading to the water from runoff rain and irrigation it may be caused due to snow melt contribute to the soil erosion but the rainy water is the main factor that leads to the movement of detachment of soil particles. the transportation for the teleportation of the soil erosion of the soil organic and inorganic particles with the water flowing along the slope deposits in the surface water bodies that leads to the landscape position change in the water is known as water erosion.

- ✓ **Hydraulic Ram:**

The hydraulic ram, sometimes abbreviated *Hydram* or *Hiram pump,* is a simple automatic device, which utilizes the kinetic energy of water falling from a moderate height to raise a part of it to much greater height. It is also called as “Zero Energy Pump”. It is continuous in operation, requires no lubrication and supervision, need less maintenance and minimum wear and tear. In hilly region of India in general and Konkan in particular, there are numerous sites where hydraulic ram could be installed, thus reducing human drudgery in carrying head load of drinking water along hills or turning unproductive and unused lands to efficient farming unit. The simplicity of construction and automatic operation of hydraulic ram make it especially adapted to remote rural are as, which often have problems of non-availability of commercial energy sources such as electricity and lack of skilled manpower for maintenance and repair of engine/motors a nd pumps.

5 RESEARCH ACTIVITIES AND ACHIEVEMENTS:

a. Varieties /Implements released: NIL

b. Research Recommendations:

Department of Soil and Water Conservation Engineering of faculty of Agricultural Engineering is working on Natural resource management for sustainable agricultural production. This department is involved in the research activities related to soil and water conservation through watershed management in Konkan region. In last 10 years it has come up with 16 research recommendations which will be beneficial to farmers of Konkan region in improving productivity of agricultural produce. These recommendations are related to improved design of soil and water conservation structures for Konkan region, life of some important structures, hydrologic behaviour of watersheds in Konkan, selection of suitable structure and development of software for scientific and location specific design of soil and water conservation measures. Estimation of erosivity at various locations, development of erodibility maps and use of remote sensing and GIS for studies on soil erosion in Konkan region. These recommendations are as follows;

MATERIALS AND METHODOLOGY

This chapter presents the techniques and methodologies adapted to design and to evaluate cement nala bund selected for study. The structure was constructed during year 2010-2011 in Shivanari Watershed under the NWDP by the Department of Agriculture, Government of Maharashtra.

Location

Dapoli Taluka is confined in between Sahyadri hills at east and Arabian Sea at west have Geographical area of 86,400 ha, out of this 52,500 ha is cultivable area, 30,200 ha is cultivated area, 1,300 ha is culturable waste land, and 3,000 ha is current fallow. Dapoli Taluka ranges from Latitude-17^{0}36' N to 17^{0}54' N and Longitude-73^{0}05'E to 73^{0}20'E. The climate in this region is humid with relative humidity ranges from 55 per cent to as high as 99 per cent (Jagtap, 2004). The details of the structure selected for study are given in Table 3.1.

Table 3.1**: Details of water harvesting structures**

Sr.No.	Description	Cement nala bund
1.	Watershed location	Shivnari
2.	Gat No.	1/3

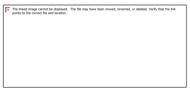
3.	Distance from Dapoli, km	27
4.	Year of construction	2010
5.	Storage volume claimed by Department of Agriculture, TCM	5.84
6.	Catchment area, ha	92 ha.

3.2) Design of cement nala bund:-

Design of cement nala bund structure was completed under hydrological design, hydraulic design and Structural design.

3.2.1) Hydrological design: watershed and climatical characteristic were consider for hydrological design of cement nala bund.

3.2.1.1) Determination of peak rate of runoff



.....(3.1
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Where,

Q_p = peak rate of runoff, m^3/s

C = Runoff coefficient

I = Intensity of runoff, cm/h for the design recurrence interval and for duration equal to the time of concentration (t_c) of the watershed

A = Area of watershed, ha

3.2.1.2) Calculation of runoff coefficient: -

Runoff coefficient was be decided upon soil type, land use and slope.

Table3.2: Value of C used in Rational method

Vegetation cover and slope	**Soil Texture**		
	Sandy loam	**Clay and silt loam**	**Stiff Clay**
Cultivation land			

0 - 5%	0.30	0.50	0.60
5 – 10%	0.40	0.60	0.70
10 – 15%	0.52	0.72	0.82
Pasture land			
0 – 5 %	0.10	0.30	0.40
5 – 10 %	0.16	0.36	0.55
10 – 15 %	0.22	0.46	0.60
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3.2.1.3) Time of concentration

Time of concentration of watershed was determined by using the maximum length of flow and fall along the line.

$$tc = 0.00032\,(L)^{0.77}\,(S)^{-0.385} \qquad \ldots\ldots(3.2)$$

Where,

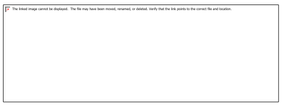
tc = Time of concentration, h

L = Length of flow, m

S = Watershed gradient, m/m

3.2.1.4) Maximum rainfall intensity

Maximum rainfall intensity, ‘I’ for Dapoli for a return period of 25 years was estimated as follow (Savane and Kubal, 2005)



…… (3.3)

Where,

I = Intensity of rainfall, cm/h for the design recurrence interval and for duration equal to the time of concentration (tc) of the watershed

T = Return period, year

t = Duration, h

3.2.2) Hydraulic design

3.2.2.1) Spillway width

The width of spillway will decided from the existing width of nala. The dimensions of spillway will be selected such that the peak flow of runoff can pass safely.

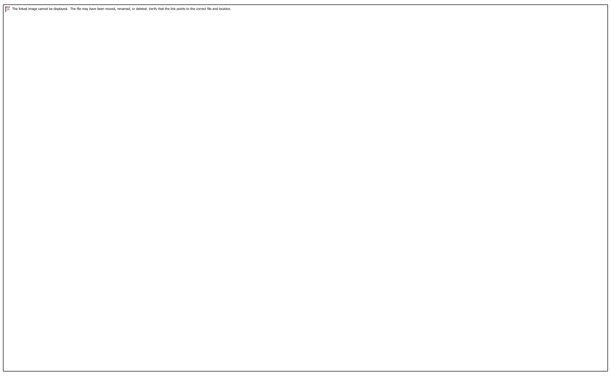
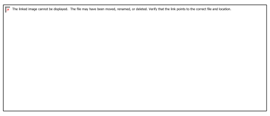


Fig 3.1. Isometric view of cement nala bund

Fig. 3.2. Foundation Sketch of Cement nala bund

3.2.2.2) Flow depth



…… (3.4)

Where,

d = Flow depth, m

Q_p = Peak rate of runoff, m^3/s

W = Spillway width, m

3.2.2.3) Freeboard (f)

f = 1.5 (Y) …… (3.5)

Where,

f = freeboard, m

Y = 0.2 to 0.4

3.2.2.4) Gross freeboard (F)

F = f + d …… (3.6)

Where,

d = Flow depth, m

3.2.2.5) Height of water storage

Height of water storage is 2/3 height of water

3.2.2.6) Total height of bund (H)

H = F + h ……. (3.7)

Where,

F = Gross freeboard, m

h= Height of water storage, m

3.2.2.7) Top width of bund (b)

…… (3.8)

Where,

H = Total height of bund, m

3.2.2.8) Bottom width of bund (B)

…… (3.9)

3.2.2.9) Side slope of bund

Side slope of bund = 1: 0.60 (H: V)

3.2.2.10) Water cushion

Height of water cushion, ... (3.10)

Width of water cushion $b_w = 1.33 \times [(d_w + h)^{0.5} \times d]$ ...... (3.11)

Depth of water cushion = (Width of water cushion) …… (3.12)

Length of water cushion, l_w = Length of Main wall

3.2.2.11) Apron

Width of apron = 2 (d + h) …… (3.13)

…… (3.14)

Length of apron= Length of water cushion

3.2.2.12) Header wall

Length of header wall = width of apron

Width of header wall (b_h)=0.6 m (minimum)

3.2.2.13) Key wall

Key wall width = Top width of bund

Key wall Height = Total height of bund

Key wall Length = 0.6 m (minimum)

3.2.2.14) Creep length

Creep length = 6 water storage depth (d)

3.2.2.15) Side wall

Length of Side wall = (B - b) + b_w + b_h …… (3.15)

Width of Side wall =0.6 m (minimum)

Height of side wall and wing wall at junction = Total height of nala bund

Height of side wall and header wall at junction = 1.5 d

3.2.2.16) Wing wall

Length of wing wall = Width of side wall

Width of wing wall = 0.6 m (minimum)

3.2.2.17) Total length of nala bund

Length of nala bund = 2(Key wall Length) + Length of main wall + 2(width of side wall)

3.2.3) Structural Design of nala bunds

Structural design of water harvesting structure ensures the stability analysis of the structure. The stability analysis of the selected structures was carried out by checking factor of safety of each structure against sliding, overturning, crushing and tension. The various forces acting on structures moments developed and other factors are calculated in each case.

Singh *et al.* (1990) stated that a structure can fail in the following ways

i. It may slide forward

ii. It may overturn

iii. The material may get crushed due to maximum compressive stress acting normal to the section and

iv. The tensile stress set up in the section, which may open the joints of the masonry and ease its failure. Therefore stability analysis of masonry structure should be made for safety of structure.

The stability of the nala bund is due to the self-weight of the wall, perhaps aided by passive resistance developed in front of the wall. These structures can be classified as

i. Structure subjected to water pressure and

ii. Structure subjected to the earth pressure

The stability of the nala bund is due to the self-weight of the wall, perhaps aided

Fig. 3.3: Analysis of forces acting on nala bund

3.4.1) Structure subjected to water pressure

Weight of dam or retaining wall acting vertically downwards W and Horizontal water pressure P

The weight of dam per unit length is given by

H ρ …… (16)

Where,

a = Top width of nala bund,m

b = Bottom width of nala bund, m

H = Total height of nala bund, m

ρ = Density of masonry,gm/cc

And this acts at a distance

…… (17)

The horizontal water pressure P is computed by using the formula for intensity of pressure of water at any depth

$$P = \omega X$$ …… (18)

Where,

ω = Density of water,gm/cc

X = Depth below surface of water where pressure is measured

The horizontal water pressure is given by the area of the pressure intensity diagram

ω ……(19)

A=

Where,

h = depth of impounding water,m

This pressure acts at a distance above the base when water is impounded, the resultant force on the dam is given by $R = (P^2 + W^2)^{0.5}$ and it act at base AB at F in Fig. 3.8.

When there is no water, the value of horizontal water pressure P is zero. Hence the resultant is given by R = W and it cut the base AB at E. The distance EF is called shift of reaction (Z). And the correlation between shift of reaction and the height of dam is given by

…… (20)

As O is the middle point of AB then

$$e = OF = BF - BO$$ ......(21)

$e = X + Z -$

Where,

e = eccentricity

3.4.3) Condition for stability of structure

a) Safety against sliding

The horizontal water pressure, P causes the section to slide but it is resisted by the frictional resistance set up at the base. If μ is the coefficient of friction the maximum friction resistance set up is equal to μW. Hence for stability against sliding, P must never exceed μ W.

Factor of safety = …… (22)

b) Safety against overturning

For stability of the section against overturning the balancing moment must be equal to overturning moment

i.e. …... (23)

Factor of safety against overturning =

= …… (24)

c) Safety against crushing

In order to avoid crushing of the masonry at the base f_{max} the maximum compressive stress acting normal to the base must be less than the permissible compressive stress for the masonry.

i.e. $f_{max} \leq$ Permissible compressive stress

Or $\leq$ Permissible compressive stress …… (25)

d) Safety against tensile stress

To avoid tension within the structure, the eccentricity 'e' should not be more than b/6 on either side of middle base, i.e. about point O. The resultant R will have to be within the middle third of base. Hence for no tension at the base.

$$X + Z = \quad b \qquad \text{…… (26)}$$

By following above procedure the cement nala bund was designed for Hydrological, Hydrualic and structural design. The designed dimension were compare with the dimension obtain from TAO office and during visit to structure the dimension were check by actual measurement.

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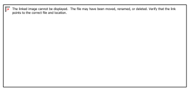

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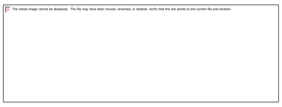

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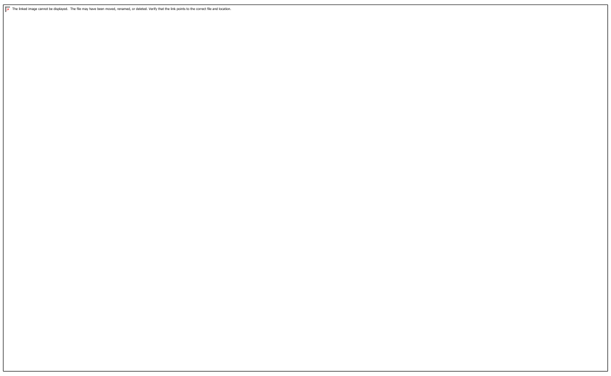

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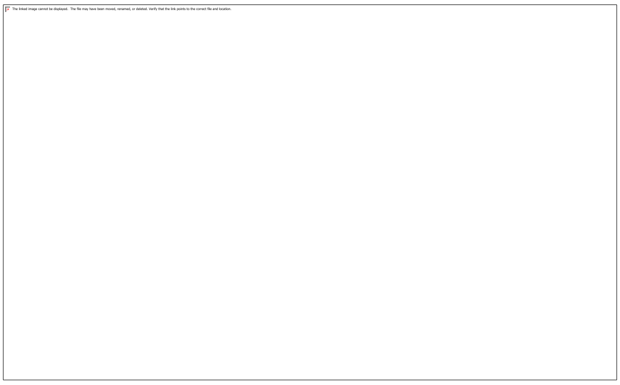

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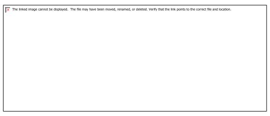 …… (3.4)

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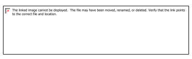 ……
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Where,

h = depth of impounding water,m

This pressure acts at a distance above the base when water is impounded, the resultant force on the dam is given by $R = (P^2 + W^2)^{0.5}$ and it act at base AB at F in Fig. 3.8.

When there is no water, the value of horizontal water pressure P is zero. Hence the resultant is given by R = W and it cut the base AB at E. The distance EF is called shift of reaction (Z). And the correlation between shift of reaction and the height of dam is given by

…… (20)

As O is the middle point of AB then

e = OF = BF – BO ......(21)

e = X + Z -

Where,

e = eccentricity

3.4.3) Condition for stability of structure

a) Safety against sliding

The horizontal water pressure, P causes the section to slide but it is resisted by the frictional resistance set up at the base. If μ is the coefficient of friction the maximum friction resistance set up is equal to μW. Hence for stability against sliding, P must never exceed μ W.

Factor of safety = …… (22)

b) Safety against overturning

For stability of the section against overturning the balancing moment must be equal to overturning moment

i.e. …...
(23)

Factor of safety against overturning =

= …… (24)

c) Safety against crushing

In order to avoid crushing of the masonry at the base f_{max} the maximum compressive stress acting normal to the base must be less than the permissible compressive stress for the masonry.

i.e. $f_{max} \leq$ Permissible compressive stress

Or $\leq$ Permissible compressive stress ……
(25)

d) Safety against tensile stress

To avoid tension within the structure, the eccentricity ‘e’ should not be more than b/6 on either side of middle base, i.e. about point O. The resultant R will have to be within the middle third of base. Hence for no tension at the base.

$$X + Z = \; b \qquad \ldots\ldots (26)$$

By following above procedure the cement nala bund was designed for Hydrological, Hydrualic and structural design. The designed dimension were compare with the dimension obtain from TAO office and during visit to structure the dimension were check by actual measurement.

SUMMARY AND CONCLUSIONS

Summary

The study was undertaken to evaluate the water harvesting structures (cement nala bund) constructed by the Department of Agriculture, Maharashtra State. The cement nala bund at Shivnari watershed situated in Dapoli Tahsil of Ratnagiri District was selected for study. The structure was constructed during 2010.

For design of cement nala bund by using Rational method peak discharge (3.692 m^3/s) was calculated. The height of cement nala bund, spillway position and relative dimensions were calculated by considering hydrological and hydraulic design procedure and structural design. Existing peak flood of watersheds was more than the estimated peak flood due to incorrect runoff coefficient. The cement nala bund was calculated for the hydrological, hydraulic and structural design. The dimension of existing nala bund was compared with design dimensions for the existing structures. The results of comparison are summarized as below

Most of the design and existing dimension of cement nala bund was more or less same. Major differences were in total height of bund, height of water cushion, depth of water cushion, width of water cushion, width of apron, thickness of apron, length of side wall. The cement nala bund existing peak flood computed by the Department of Agriculture (21.722m^3/s) was more than the estimated peak flood(3.692m^3/s). The cost of construction of existing nala bund was found to be higher than the cost calculated for the structure, designed by the standard procedure. Stability analysis revealed that selected nala bund was found to be safe from stability analysis.

Conclusions

From the analysis of data and results obtained from comparison between existing and designed dimensions of the nala bund following conclusions are deduced.

1. In cement nala bund, total height of existing cement nala bund was 0.6 m higher than designed nala bund. Dimensions of other components viz. total length of bund, bottom width of bund, height of water cushion, width of water cushion, width of apron, thickness of apron, key wall length, key wall height, length of wing wall, length of side wall were lesser than existing cement nala bund structure.

2. The cost of construction of dam computed by Department of Agriculture was found to be 62.86 % higher than the actual cost calculated by the standard design procedure.

3. The existing and designed dimensions of nala bund are found to be safe from stability point of view.

4. The procedure used by the Department of Agricultural needs to be modified by considering the hydrologic, hydraulic and structural design and form economical point of view of the nala bund.

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