RESEARCH PAPER *International Journal of Agricultural Engineering* | Volume 5 | Issue 1 | April, 2012 | 25 – 27

Evaluation of earthen nala bunds for the Konkan region of Maharashtra state

V.T. BOMBALE, M.R. MORE AND D.M. MAHALE

Received : 06.08.2011; Revised : 30.10.2011; Accepted : 26.01.2012

See end of the Paper for authors' affiliations

Correspondence to:

V.T. BOMBALE
Aditya College of Agricultural Engineering, BEED (M.S.) INDIA

Abstract **:** The present study was undertaken in the year 2005-2006 in selected watersheds of Dapoli Tahshil in Ratnagiri District of Maharashtra State. Two earthen nala bunds ENB1 and ENB2 selected for the study were situated at the outlets of watershed Pisai and Shirkhal, respectively. The selected nala bunds were tested for hydrological, hydraulic and structural design before execution so as to ensure proper design of structures. The dimensions of emergency flood spillway were selected in such a way that the discharge passing through flood spillway was greater than peak runoff rate. The total earthwork for the earthen nala bunds was computed to find the total cost of their construction. The earthen nala bund structures designed by considering hydrological data were compared with the earthen nala bund designed by the Department of Agriculture of the State Government. The cross-sectional area of earthen nala bund designed by considering the storage volume was less as compared to those designed by Department of Agriculture. Major differences were in height, top width, base width and side slope of the structures. The cost of construction of all the earthen nala bunds claimed by Department of Agriculture was overestimated. All the selected and designed dimensions of earthen nala bunds were found to be safe from stability analysis. Runoff volumes estimated for ENB1 and ENB2 were 84448.8 m^3 and 84981.6 m^3, respectively. The peak rate of runoff computed by using the rational formula for the design of spillway were 1.72 m^3/s and 1.71 m^3/s. The total cost of construction of earthen nala bunds ENB1 and ENB2 as per the standard procedure was Rs. 156945/- and Rs. 223998/-, respectively. The study revealed that the design procedure used by the Department of Agriculture needs to be modified by considering the hydrological, hydraulic and structural design of the earthen nala bunds.

Key words **:** Earthen nala bund, Cross sectional area, Stability analysis

How to cite this paper **:** Bombale, V.T., More, M.R. and Mahale, D.M. (2012). Evaluation of earthen nala bunds for the Konkan region of Maharashtra state. *Internat. J. Agric. Engg.*, **5**(1) : 25-27.

Soil and water are the two most important natural resources required for the survival of living things on the earth. The environment and economy is driven by these two vital resources. Therefore, for the sustainable development of environment, economy and to provide life enhancing systems for human being and animals it is inevitable to inculcate efficient management practices of land, water and vegetation.

Konkan region constitutes 10 per cent of the geographical area of Maharashtra state and receives 46 per cent of the rainfall of Maharashtra. Farmers of Konkan region are lacking in irrigation potential and forced to take only one rainfed crop in the year. This has put the rural people in vicious cycle of 'poverty-low purchasing power-low investment-less productivity-poverty'. To overcome the problem, development of land and water resources through scientific and integrated approach on watershed basis is necessary (Mahale *et al.*, 2004). Hence, harvesting and harnessing the runoff water is very important.

Traditionally, 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, earthen nala bunds, 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.

It is essential to make survey and study the geo-morphology of watershed for planning, designing and executing the works of soil and water conservation structures. Most of the time, the morphological characteristics of watershed are not taken into consideration, while designing water harvesting 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.

The Department of Agriculture, Government of Maharashtra had constructed number of earthen nala bunds under various soil and water conservation programmes. The Department Agriculture has their own standards and norms for the design to suit the field conditions and administrative procedures. However, such simplifications in the design may lead to improper design, which may result in more construction cost and improper functioning.

METHODOLOGY

The study was conducted in the year 2005-2006 in Dapoli Tahshil in Ratnagiri district of Maharashtra state. Two earthen nala bunds ENB_1 and ENB_2 selected for the study were situated at the outlets of watershed Pisai and Shirkhal, respectively. Dapoli Taluka is confined in between Sahyadri hills at the East and Arabian Sea at the West. The daily rainfall data for 25 years from 1981-2005 was obtained from the Agro-meteorological observatory of the University. The rainfall data was to find out the meteorological week with maximum rainfall.

The runoff volume was calculated by using Curve Number method. Runoff depth of watershed ENB_1 and ENB_2 was calculated. Spillway should be designed such that the design peak discharge is less than or equal to spillway discharge. Design peak discharge was calculated by using rational formula. The gross height of the embankment structure was determined in such a way that the storage volume of the embankment is greater than or equal to volume of storage calculated form runoff.

As the material of earthen nala bund is sand with clay core, therefore, upstream side slope and downstream side slope selected as 3:1 and 2.5:1, respectively. Length of earthen nala bund was decided for gross height and for keeping the top surface level along a centre line of construction of earthen nala bund. Base width of nala bund was calculated at different chainages along the length, after considering top width and side slopes. Total volume was calculated by adding the volume in different sections. The width of spillway was decided from the existing width of nala. The dimensions of spillway were selected such a way that the peak flow of runoff can pass safely.

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 were calculated in each case.

RESULTS AND DISCUSSION

The runoff volume was estimated by CN method for the week with maximum rainfall in 25 years recurrence interval. The runoff, which can stored in present structures was computed. The runoff volume for 25 years return period and storage volume is presented in Table 1. The desired and existing dimensions of earthen nala bund are given in Table 2. For earthen nala bund ENB_1 gross height is determined as

Table 1 : Runoff volume from watersheds and storage volume in nala bunds

Earthen nala bunds	Runoff volume by CN method, m^3	Storage volume in nala bunds, m^3	Excess runoff, m^3	Excess runoff percentage
ENB_1	84448.8	11484.0	72964.8	86.40
ENB_2	84981.6	10328.0	74653.6	87.84

Table 2 : Desired and existing dimensions of earthen nala bunds

Sr. No.	Description	Earthen nala bunds			
		ENB_1		ENB_2	
		Desired dimensions	Existing dimensions	Desired dimensions	Existing dimensions
1.	Normal water level, m	3.00	3.00	3.00	3.00
2.	Freeboard for safety, m	0.33	-	0.32	-
3.	Flow depth in flood spillway, m	0.40	0.60	0.40	0.60
4.	Gross freeboard, m	1.03	1.50	1.02	1.20
5.	Consolidation, m	0.20	-	0.20	-
6.	Gross height of bund, m	3.92	5.10	3.90	4.80
7.	Top width, m	2.28	2.00	2.28	2.00
8.	Upstream slope (H:V)	3:1	2.5:1	3:1	2.5:1
9.	Downstream slope (H:V)	2.5:1	2.5:1	2.5:1	2:1
10.	Bottom width, m	23.84	27.50	23.73	23.60
11.	Length of embankment, m	55.00	55.00	75.00	75.00
12.	Fill volume for main wall, m^3	1313.85	1807.90	1857	1894.21
13.	Core wall volume, m^3	357.10	408.35	509.46	579.77

3.92 m after considering normal water level, flood storage depth, flow depth in flood spillway, net freeboard and consolidation allowance. However, the gross height determined by the Department of Agriculture is 5.10 m, which is 1.18 m more than the desired one. The Department has considered 1.50 m freeboard for safety in addition to normal water level and flow depth in flood spillway without any technical consideration.

For earthen nala bund ENB_2 the existing gross height 4.80 m is greater than the designed gross height by 0.90 m. Thus, increases the cross section of bund and increase the cost of construction. Top width of ENB_1 is worked out as 2.28 m against existing top width of 2.00 m. The side slope of earthen nala bund depends upon the fill material, the shearing resistance of foundation soil and duration of inundation. As the materials of bund are sand with clay core wall, the u/s side slope should be selected 3:1 and d/s side slope 2.5:1. However, existing slopes on u/s side are 2.5: 1 for both structure and for d/s side 2.5: 1 and 2:1 for ENB_1 and ENB2, respectively.

Bottom widths are worked out to be 23.84 m and 23.73 m for NB_1 and NB_2, respectively where as existing bottom widths are 27.50 and 23.60 m. The study revealed that the dimensions of the existing structures are more than the desired dimensions. Fill volume were also high for the existing structures, than the required one. These volumes were high due to more height of structures.

Conclusion:

The catchment area of earthen nala bund ENB_1 and ENB_2 were 15.85 ha and 15.95 ha, respectively with average slopes of about 2.77 and 2.50 per cent. The per cent of excess runoff for 25 years return period was 86.40 and 87.84 for earthen nala bund ENB_1 and ENB_2 , respectively. For existing and standard designed dimensions of earthen nala bund structure ENB_1 and ENB_2, there was significant difference between standard design and existing structures regarding height, top width, base width and side slopes. The depth of existing flood spillways for both the earthen nala bunds were found to be more than the desired depth. The velocities of flow of water through the design sections of flood spillway were within the safe limit. The cost of construction of existing earthen nala bunds were found to be higher than the cost calculated for the structures which were designed by the standard procedure. Stability analysis revealed that all selected earthen nala bund were found to be safe against various types of failures. From the analysis of data and results obtained from comparison between existing and designed dimensions of earthen nala bunds it is concluded that due to more freeboard and more flow depth in flood spillway, dimension of earthen nala bund was increased. The earthen nala bund designed with storage ratio 6 is found economical. The flood spillway in case of earthen nala bund should be provided with vegetal cover so as to reduce the velocity of following water, so that there will no scoring in the flood spillway. In case of existing earthen nala bunds, side slopes should be flatter so as to suit the fill material. For earthen nala bund, the cost of construction computed by Department of Agriculture was found higher than the actual cost calculated by the standard design procedure. All the existing and designed dimensions of earthen nala bunds are found to be safe from stability point of view. The procedure used by the Department of Agricultural needs to be modified by considering the hydrologic, hydraulic and structure design and form economical point of view of the earthen nala bunds. It is necessary to make provision for repair and maintenance cost of earthen nala bund in the original estimate.

Authors' affiliations:

M.R. MORE, Department of Soil and Water Conservation, College of Agricultural Engineering and Technology, Marathwrada Agricultural University, PARBHANI (M.S.) INDIA

D.M. MAHALE, Department of Soil and Water Conservation Engineering, College of Agricultural Engineering and Technology, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, RATNAGIRI (M.S.) INDIA

REFERENCES

Goel, P.K. and Singh, H.B. (1996). Impact of soil and water conservation measures on ground water availability. *Indian J. Soil Conservation*, **24**(1): 19-24.

Gouda, D.S.M., Maurya, N.L., Belgauni, M.I., Mansur, C.P. and Kubsad, V.P. (1992). Impact of water harvesting structures (Nala Bund) on ground water recharge. *Indian J. Soil Conservation*, **20** (3): 65 - 71.

Mahale, D.M., Thokal, R.T., Malankar, B.G., Satvalekar, D.D., Nandgude, S.B., Powar, A.G. and More, M.R. (2004). Effect of soil and water conservation measures on groundwater recharge in Priyadarshini watershed. Souvenir, National seminar on 'Integrated Water Resources: Planning and Management' held at BITS Pilani. pp.349-356.

Shende, G.S. (1988). Evaluation of soil and water conservation structures in the selected watersheds of Akola District of Maharashtra. M. Tech. (Agril. Engg.) Thesis, Mahatma Phule Krishi Vidyapeeth, Rahuri, AHMEDNAGAR, M.S. (India).

***