30th WEDC International Conference, Vientiane, Lao PDR, 2004

PEOPLE-CENTRED APPROACHES TO WATER AND ENVIRONMENTAL SANITATION

Water bioengineering techniques for efficient water harvesting system

R.P. Vasani, India

Construction of check dam is the first step towards field water harvesting. Check dams stop water flow and raise it up to their height. Average annual rainfall is higher than what is needed for the country, still we face water crisis in major parts of India. Therefore, the need to develop economically viable techniques to manage the available water. Present practice in our country is to construct a check dam in brick masonry, rubble masonry or reinforced cement concrete. These are rigid in nature and may be subjected to uneven settlement, cracking etc resulting in failures. This paper proposes an alternative to such type of structures. An "Eco-friendly flexible check dam – A case study" with Bioengineering techniques has been described. The results are compared with conventional check dams and they indicate that saving on construction cost is approximately 55% with the new alternative suggested, with more water storage.

Introduction

Water is precious. In spite of average annual rainfall higher than what is needed for the country, India faces water crises in its majority of parts. There is a need to develop economically viable techniques to manage the available water. It should be planned to harvest rain water before the commencement of inter-village disputes for water surface. Everyone including individuals, public bodies and governments must conserve rain water. For small areas, underground water storage system of recharging ground water through wells, roof top water harvesting etc, should be adopted. For relatively large areas, check dams can be constructed.

The basic role of Bioengineering techniques is planning and construction of the water resources protection measures, while also considering the need for maintenance and the cost of such works during the ensuing years. The Bioengineering techniques are slope protection and erosion control measures at the surface and shallow seated stabilization of banks, waterways, river courses, which include the range of available construction materials and specific construction methods. Its main aim is to stimulate interest in, and encourage the use of, live plant material in the derivation of durable erosion control methods.

Present Study:

In the present case study, a polyethylene sheet (a flexible membrane) is erected across the water course supported by empty bags, filled with soil on both the sides. A bunch of rubble tied by chain link fence is put on the cement bags to protect the structure when water overflows. Thus, costly concrete masonry is replaced by earth waste material. Thus, it saves cement or bricks which are energy hungry materials.

Construction procedure:

Present practice is to construct a check dam in brick masonry, rubble masonry or reinforced cement concrete. These type of structures are rigid in nature. They are constructed on flexible earth base in most of the cases. They may be subjected to uneven settlements, cracking etc resulting in excessive seepage or some times in failure. So to avoid this, an alternative to such type of structures like "Flexible Check Dam With Bioengineering Technique" can be used.

Due to this new selected technique the structure prevents the water, flowing downstream under normal conditions, and allows excess water to pass through, without damaging the structure.

The location is finalized based on reconnaissance and contour survey (Plan and section is shown in the figures)

- The foundation area is cleaned.
- Approximately 1m deep and 0.6m wide foundation is excavated perpendicular to the alignment of the flow.
- Polyethylene sheet is spread on the bottom of the foundation and kept vertical by posts at suitable interval.
- Empty cement bags filled with clay soil are kept on both the sides of 100 microns polyethylene sheet.
- The soil filled bags are laid with 1:1 slope on upstream side and 1:5 slope on downstream side.
- Chain link fence is put on masonry and rubble is placed on it, which is covered by chain link fence on all sides so that bunch is formed. (i.e. gabion is developed)
- The sides i.e. junctions are properly protected using earth filled bags and gabions.

Advantages:

1) Low construction cost
2) Minimum energy consumption

3) Higher labour component
4) No skilled labour is required
5) Convenient to raise or reduce the height
6) Easy maintenance at a very low cost. The material and the structure can be shifted to other location with a minimum cost.

Case study:

The Panjrapole trust based at Baroda, needed drinking water for cattle and for growing grass for cattle feed. A small drain (nalla) passes through the land. Longitudinal Section of the drain was prepared. The level difference between the upstream and the downstream boundary of the drain was observed to be 2m. So, it was decided to construct a check dam of one and a half meter depth.

So, an innovative idea was developed to construct a check dam as per mentioned procedure. The structure stores 50 million liters of water each year, during monsoon season. The comparison indicates that there is approximately 55% saving of construction cost in eco-friendly flexible check dam as compared to conventional check dam. For protection of water course banks against erosion and depending on the fluctuation of the water level, the water profile is assessed and separated into the results of the vegetation survey. So, depending upon the water level on site, the availability of suitable planting material, like root ball or shoot planting or neem can be planted. The planting of shoots and culums is the cheapest and fastest method.

Government of India as well as State Government has taken up water harvesting projects on a large scale. A special policy has been defined to ensure the participation of local people. Government contributes some amount of the project cost and the balance is being borne by the beneficiaries. By applying some innovative technology, important building material like cement and steel can be saved. The saving in these materials will enable their use in other important projects.

Details of the constructed structures	
Bed width of the drain	10m
Length of the structure at top	15m
Top width	0.5m
Side slopes: Upstream Downstream	 1:1 1:5
Chain link size openings	150mm x 150mm
Wire size	3 to 4m
Height of the structure	1.5m
Depth of the structure	1.0m
Polyethylene membranes thickness	100 microns

Results:

Comparison with a conventional concrete check dam and the flexible check dam:

Table 1. Typical estimate for a concrete check dam (Base year 2003)

Sr	Description	Quantity (App.)	Unit	Rate in Rs. (Ind) (2003)	Amount Rs. (App.) (Ind)
1.	Excavation	300.00	m^3	42/-	12,600/-
2.	Foundation concrete 1:2:4	30.00	m^3	1200/-	36,000/-
3.	Providing C.C 1:3:6	180.00	m^3	1300/-	2,34,000/-
4.	Earthwork in embankment		m^3		1000/-
5.	Miscellaneous		Lump sum		2000/-
				Total	**2,85,600/-**

Table 2. Typical estimate for the flexible check dam

Sr	Description	Quantity (App.)	Unit	Rate in Rs. (Ind) (2003)	Amount Rs. (App.) (Ind)
1.	Excavation	15.00	m^3	50/-	750/-
2.	Polyethylene sheet	45.00	m^2	45/-	2025/-
3.	Empty bag fill masonry	150.00	m^3	125/-	18,750/-
4.	Gable filling	40.00	m^3	350/-	14000/-
5.	Chain link fencing	180.00	m^2	75/-	13,500/-
6.	Miscellaneous.		Lump sum		2000/-
				Total	**51,025/-**

Construction of the check dams is the right step towards field harvesting. Check dams stop water flow and raise it up to its height. So all efforts to conserve even a drop of rain water should be made to harvest the water to the extent possible.

Lessons learned:

- Difficulties faced while erecting the polyethylene sheet. It was solved by keeping more bags.
- After first rain with storm, the stability of the dam was disturbed, but after tying more chain link on the cement bag the problem was solved and also allowed the water to over flow.

- Till date most of the check dams are constructed on very small drain and nallas with satisfactory results. One should investigate the scope of using the technology for large rivers with heavy flows permitting the floodwater to flow above the check dams with least damage to the structure. It may continue using concrete only where essential, say for example, on a rocky foundation for the impervious core but it is essential to use earth and waste materials in major part of the construction.

Reference:

INAE (1998). Low cost housing and infrastructure. INAE, India.

IWWA (2004). Water security present & future. 36th Annual convention of IWWA page 146-149.

Kakade, B.K. Gabion structure with ferro cement impervious barrier.

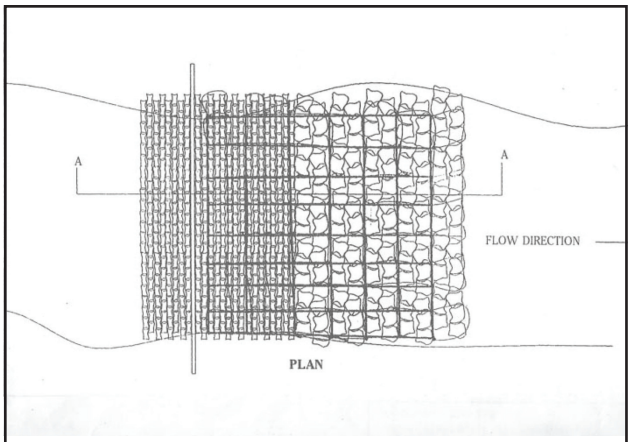

Figure 1. Plan of the Nalla
(Selected site)

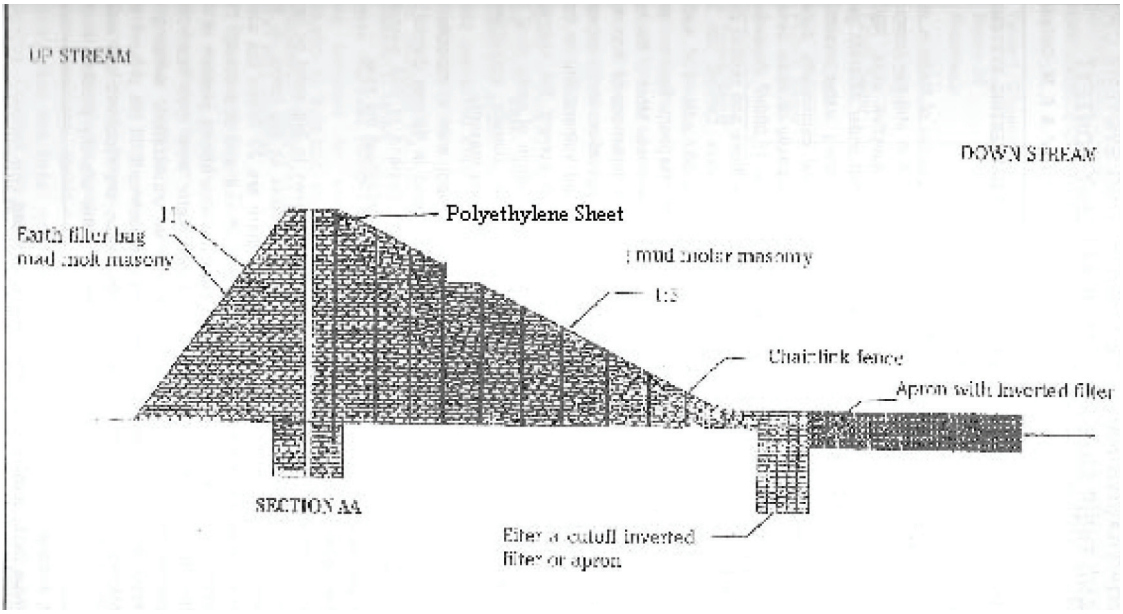

Figure 2. Section A-A