Sand Dam Reservoir – Need Of Semi Arid Areas

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ABSTRACT:

In dry land areas of India, episodic shortages of water are quite common. In many areas, Women have to spend days traveling long distances looking for water. Any development or rehabilitation of water supply schemes should aim to ensure reliable and adequate water supply and sanitation. The development of appropriate and affordable community water supply systems calls for innovative rain and runoff water management technologies for domestic, livestock, and supplemental irrigation uses. The water held in sand dam behind the dam spread horizontally creating a permanent increase in water table allowing trees grow natural and transforming the local ecology. The dam creates a natural buffer that reduces the threat posed by flooding and drought & built resilience of communities to cope with the impacts of climate change in semiarid regions. Sand dam retains 25 % water of sand stored on its upstream which will flow down if the sand dam is not constructed. Sand dams are relatively simple to construct and can be built by a constituent community for their own empowerment and self-sufficiency. The materials required are mostly local and reconfigured from the stream itself.

Keywords - Ground water, permeability, sand dam, sand reservoir**.**

1. INTRODUCTION

A sand storage dam or sand dam is a small dam build on and into the riverbed of a seasonal river. The functioning of a sand dam is based on sedimentation of coarse sand upstream of the structure by which the natural storage capacity of the riverbed aquifer is enlarged. The aquifer fills with water during the wet season, resulting from surface runoff and groundwater recharge within the catchments. When the riverbed aquifer is full, usually within one or two large rainfall events, the river starts to flow as it does in the absence of the dam. However, the groundwater flow through the riverbed is now obstructed by the sand storage dam, creating additional groundwater storage for the community.

A sand dam is a partially subsurface dam build in a dry and sandy riverbed onto bedrock or an impermeable layer. It is constructed across a river to block the subsurface flow of water, hence creating a reservoir upstream of the dam within the riverbed material. The main function of sand dams is to store water in the sand of the riverbed and therefore increase the volume of sand and water in riverbeds. The reservoir will be filled due to percolation of water during flood events. The water within the riverbed (reservoir) can be used for domestic use and livestock. Other functions of sand dams can be sand harvesting, rehabilitation of gullies and groundwater recharge.

A sand dam has several functions:

- Increasing water supply by storing water in the sandy riverbed
- Sand harvesting and rehabilitating of gullies
- Groundwater recharge

1.1 Objective

- To increase the water table higher and over a larger area compared to individual units.
- To provide ecological regeneration.
- To provide drinking water and also water for rural commercial development activities.
- To protect water against evaporation.
- Block the underground flow of water between the voids in the sand.

1.2 Need Of Sand Dam

The semi-arid region in which rural communities depend mostly on livestock farming and small-scale agriculture, both activities are highly constrained by water availability, there being no perennial rivers and with rainfall varying highly, both spatially and temporally. Water harvesting has proven to be an attractive decentralized water source in areas where other means of water supply have little potential. However, roof water harvesting is not effective from thatched roofs and storage of surface runoff in tanks can only provide sufficient water for the dry period and the quality is questionable. Therefore the sand dam technology provides an attractive solution for the people.

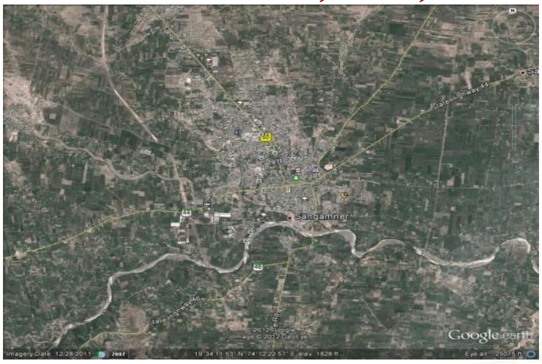


Fig. No. 1: Pravara River at Sangamner

2. METHODOLOGY

2.1 Basic Principle:

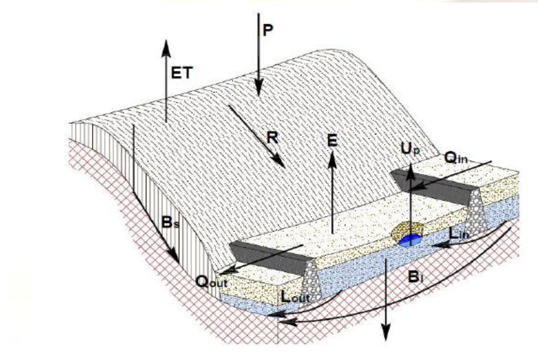


Fig No. 2: Important Water Balance Components

Water balance components-

ET- Evapo (transpi) ration from slopes.
E - Evaporation from riverbed.
P - Precipitation.
R -Surface runoff from slopes to river.
B_s - Groundwater base flow from slopes to river.
B_f - Shallow and deep longitudinal base flow.
Q_{out}-River discharge outflow over downstream dam.
L_{out}- Leakage underneath and around downstream dam.
Q_{in} - River discharge inflow over upstream dam.
Up - Use of water (abstraction).
Gr-Loss of water into the 'impermeable ground.

2.2 Practical steps within a Sand Dam Project

The step-wise approach in how to implement a sand dam project is shown in fig. No. 7. By referring fig. No. 7 for the purpose of sand dam construction, select the site at Sangamner locality in the basin of Pravara river from the study of site condition, nature of river bed and the strata of river bed. After selecting proper site and location the field work is done. In field work the longitudinal and cross section profile levelling is done.

2.3 Precipitation and Evaporation Data:

Higher annual precipitation will mean more storm events. These areas have a higher suitability based on precipitation compared to regions with a lower annual rainfall. Also, to calculate the yield of a sand dam, it is essential to know the climatologically behavior of an area.

Rainfall data of last 30 years was collected and shown in Table no.1

Average rainfall = 12143.6/ 30
= 404.78 mm

2.4 Measurement of Sand Depth

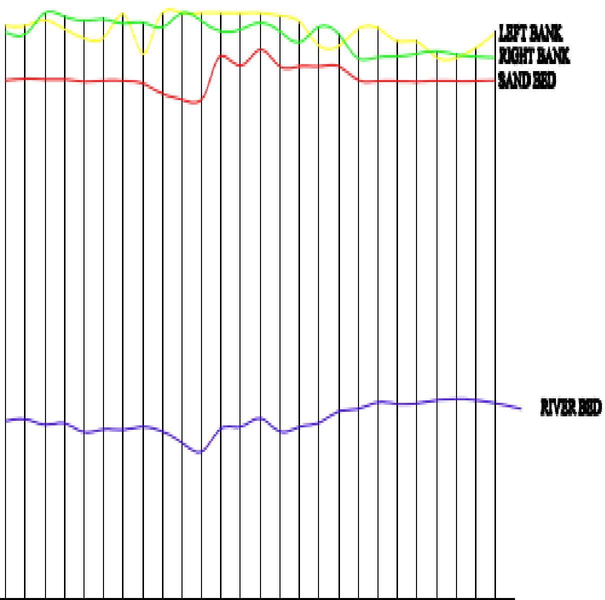
The depth of the basement or impermeable layer in the riverbed with respect to the riverbed surface is of importance to decide where the sand storage dam should be build. It should be constructed at the location where the impermeable layer is closest to the riverbed surface. Preferably, the basement upstream of this location is deeper, to get a larger sand dam aquifer. The depth of the sand in the riverbed can be surveyed by using an iron rod with a diameter of 16 mm (5/8") notches should be cut in the probing rods for every 25 cm to collect sand samples when the rods are pulled up.

Other method for measurement of sand depth is core drilling. This method is used because the depth of sand in river is more than the length of probing rod. So we used core drilling method, in this method hollow hard iron pipe with beveled mouth edge cutter is inserting in the sand bed, Sand depth is measured with this method at a site is = 9.0 m.

Fig. No.3: Core Drilling

2.5 Longitudinal Profile and Cross Section

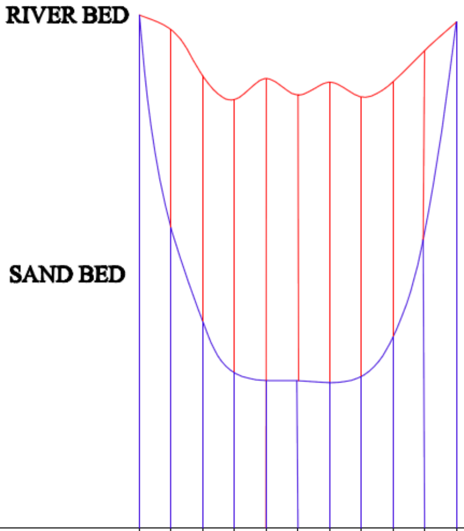
The potential riverbed section(s) should be investigated in further detail for suitability for Sand dams. This can be done by taking measurements of the riverbed dimensions along the selected river section. Here 250m of longitudinal level profile is carry out. & 10m interval for cross section profile.



R.L. OF RIGHT BANK OF RIVER	100.600	100.555	101.135	101.040	100.925	100.960	100.850	100.875	100.750	101.130	100.920	100.630	100.690
R.L. OF LEFT BANK OF RIVER	100.790	100.775	100.935	100.960	100.440	100.460	101.090	101.105	101.140	101.135	101.140	101.140	101.135
R.L. OF RIVER BED	99.305	99.325	99.305	99.290	99.250	99.275	99.265	99.195	98.915	98.755	98.630	99.950	99.965
R.L. OF SAND BED	89.905	89.955	89.805	89.840	89.600	89.675	89.665	89.745	89.615	89.305	89.060	89.700	89.865
CHAINAGE	0	10	20	30	40	50	60	70	80	90	100	110	120

R.L. OF RIGHT BANK OF RIVER	100.860	100.625	100.335	100.755	100.555	99.885	99.915	99.940	100.015	100.075	99.990	99.905	99.650
R.L. OF LEFT BANK OF RIVER	101.140	101.100	100.495	100.225	100.230	100.700	100.720	100.360	100.340	99.905	99.895	99.890	100.365
R.L. OF RIVER BED	99.960	100.125	99.665	99.670	99.660	99.665	99.290	99.265	99.270	99.250	99.270	99.260	99.275
R.L. OF SAND BED	89.940	89.975	89.615	89.740	89.860	90.165	90.240	90.415	90.370	90.400	90.470	90.510	90.525
CHAINAGE	130	140	150	160	170	180	190	200	210	220	230	240	250

Fig. No.4: Longitudinal Profile



R.L. OF RIVER BED	101.140	100.685	99.225	98.485	99.145	98.630	99.030	98.570	99.045	100.025	100.920
R.L. OF SAND BED	92.940	92.485	90.775	89.885	89.645	89.060	89.580	89.770	90.445	92.025	92.970
CHAINAGE	55	40	30	20	10	00	10	20	30	40	55

Fig. No. 5 Cross Section at 100m Chainage

By knowing the longitudinal and cross-sectional profile, a calculation of the reservoir capacity can be made. In figure 5 is given of a cross-section where the sand is deepest. It is important to take measurements every 10 meter across the riverbed to determine the riverbed morphology.

2.6 Determination of Permeability

As per IS 2720, The coefficient of permeability of sand is found out by constant head permeability method on compacted sample of sand by constant head permeameter.

The coefficient of permeability of sand is **0. 1342$\times$ 10^{-2} mm/sec.** The type of sand is medium sand which has **Good** Drainage property As per IS 2720.

3. HYDROLOGICAL DESIGN

Maximum discharge formula=

$$\frac{1}{n} \times A \times R^{\frac{2}{3}} \times S^{\frac{1}{2}}$$

Where, n = 0.025 for good river condition.

$S = \frac{1}{425}$ from L-section.

P = Perimeter 125m measured at site.

Normal flood level = 5.27m.

Cross section of river for design shown in fig no.6

$A = (\frac{100+120}{2}) \times 5.27 = 579.7 m^2$

$R = \frac{A}{P} = \frac{579.4}{125} = 4.64\text{m}$

$$Q = \frac{1}{0.025} \times 579.7 \times (4.64)^{\frac{2}{3}} \times \left(\frac{1}{425}\right)^{\frac{1}{2}}$$

$= 3146.78 m^2$

Discharge through sand

Q= KiA

$= 0.1342 \times 10^{-2} \times 10^{-3} \times 12.18 \times \left(\frac{100+50}{2}\right) \times 9$

= 0.01 Cumec --- Very small hence neglected

Sand storage capacity of dam

Volume of Sand (V sand) = $\frac{L \times T \times D}{6}$

$= \frac{100 \times 9 \times 500}{6} = 75 \times 10^3$ Cu.m

L =Length of Dam Wall
T =Max through Back assume-500m
D =Depth of Sand

Vol. of water extraction = $75 \times 10^3 \times \frac{25}{100}$

$= 18750$ Cu.m

$= 18.75 \times 10^6$ liters

4. CONCLUSIONS

Water scarcity is perceived as the major bottleneck to development in the arid and semi-arid and innovative ways of rainwater harvesting are worthwhile. Sand dam technology that artificially enhances traditional water harvesting knowledge if well sited can bank of up to sufficient capacity of clean water for domestic use thereby alleviating water shortages during drought periods. Drinking water or potable water is water pure enough to be consumed or used with low risk of immediate harm. The water supplied by sand dam is used for households, commercial and industry is all of drinking water standard, even though only a small proportion is actually consumed or used in food preparation. Typical uses include washing or landscape irrigation.

The water held in sand dam behind the dam spread horizontally creating a permanent increase in water table allowing trees grow natural and transforming the local ecology. The dam creates a natural buffer that reduces the threat posed by flooding and drought & built resilience of communities to cope with the impacts of climate change in semiarid regions. Sand dam retains 25 % water of sand stored on its upstream which will flow down if the sand dam is not constructed.

Sand dams are relatively simple to construct and can be built by a constituent community for their own empowerment and self-sufficiency. The materials required are mostly local and reconfigured from the stream itself. Should the infrastructure fail, it can be repaired or remade. Insects that carry water-borne diseases are absent as they cannot breed in dry sand topping the underground water reservoir. For the same reason, no pollution is caused by frogs, snakes and other animals as they cannot live in the sand. Pollution from livestock and other animals is nearly absent as water is under the surface of the upper dry sand.

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Table No. 1: Annual rainfall data of Sangamner city

Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Rainfall (mm)	459	315	363	204	204	260	306	461	458	445
Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Rainfall (mm)	450	342	435	416.6	290	566	402	489	348	528
Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Rainfall (mm)	337	459	380	570	456	485	391	469	403	352

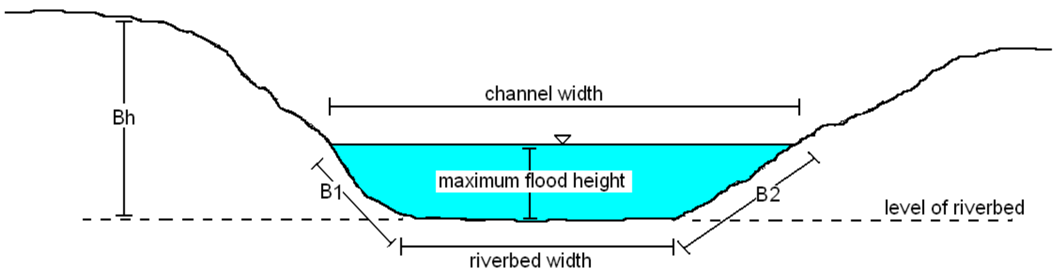

Fig. No.6 : Cross section of river

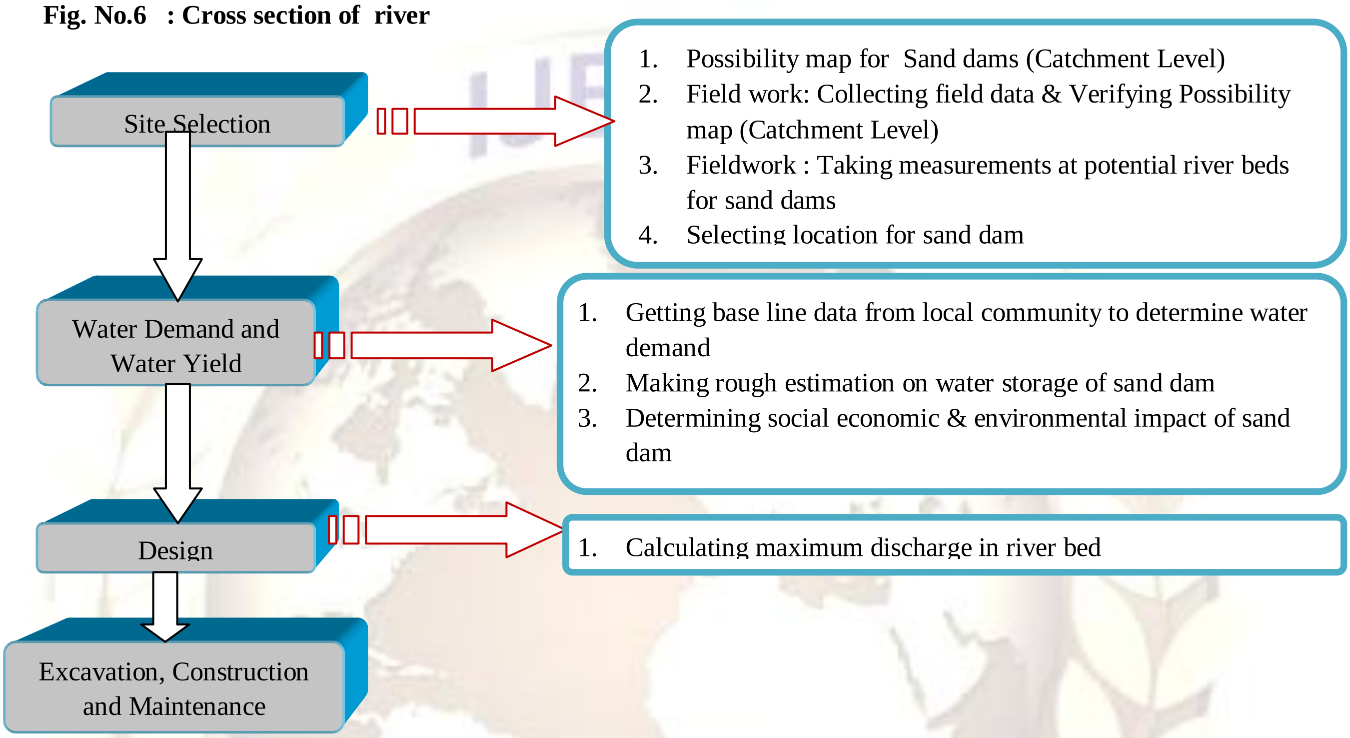

Fig. No.7 Practical Steps for Sand Dam