Research Paper Engineering

Design Principales And Consideration For Pressurized Irrigation System ---- A Case Study

* Mrs. Seema A. Rathod ** Mrs. Suvarna D. Shah

* P.G.Student, Civil Engineering Dept. M.S.University, Vadodara

** Associate professor, Civil Engineering Dept., M.S.University, Vadodara

ABSTRACT

India has one of the largest and most ambitious irrigation programmes in the world with net irrigated area exceeding 47 million hectares. However, the overall project efficiency from the headwork to the farmer's field has been quite low which leads to not only poor utilization of irrigation potential created at huge cost, but also aggravates the degradation of soil and water resources and thereby endangers the sustainability of agricultural production system. As the cost of creating additional irrigation potential in terms of financial, human and environmental aspects has increased tremendously, need of the hour is to increase the irrigation efficiency of existing projects and use saved water for irrigating new areas or meeting the demand of non-agricultural sector. The contribution of application efficiency to poor irrigation efficiency is quite high and therefore increasing application efficiency by a shift in application method from surface to pressurized system has potential of vastly improving irrigation efficiency. To evaluate feasibility of this concept, a study was initiated at one outlet of a minor irrigation canal command area. The system has been designed in such a way that it provides pressurized irrigation network system up to farmers field and micro-irrigation system in each field of farmers. To take care of sediment in the canal water, there are three stages of filtration: first by hydro cyclone filter which filters heavy suspended materials viz. sand, silt, etc., then by the sand filter and finally by the screen filter.

Keywords : Irrigation efficiency, Water saving , Pressurized irrigation System, micro irrigation, Canal Command Area

INTRODUCTION

Irrigation has been a high priority area in economic development of India with more than 50% of all public expenditure on agriculture having been spent on irrigation alone. The land area under irrigation has expanded from 22.6 million hectares in 1950 to 90 million hectares in 2000, with 52% area being irrigated by surface water through canal network. Unfortunately, the overall efficiency of canal irrigation system worldwide is very low which leads to poor utilization of irrigation potential, created at huge cost.

In India, most of the irrigation networks are unlined and huge amount of the irrigation water is lost in main canal, distributory, minors and field channels. Navalwala (1991) found that about 71% of the irrigation water is lost in the whole process of its conveyance from head works and application in the field. The breakup of the losses is main and branch canal (15%), distributaries (7%), water courses (22%) and field losses of 27%. The situation is particularly bad in minor irrigation systems of plateau areas of eastern India, where the overall irrigation efficiency varies between 20% to 35%. These systems are located in coarse soil area and have rolling topography. Due to this, the conveyance losses are high and the system suffers from inadequate supply and poor water availability especially during lean season. Therefore the need of the hour is to increase irrigation efficiency of existing projects and use saved water for irrigating new areas or reducing the gap between potential and actual irrigated areas. Shifting to pressurized irrigation can be an option for increasing this irrigation efficiency.

Modernization of the irrigation system is required for improving the overall project efficiency of irrigation projects and increasing the water productivity. Modernization and optimization of irrigation systems have often been promoted in public and private agendas as tools to improve irrigation efficiency and producing more agricultural goods with less water input. Playan and Maetos (2006) has discussed a number of irrigation modernization and optimization measures by giving particular attention to improvement in irrigation management. This showed much better economic return than the improvement of irrigation structures. Shifting from surface irrigation to pressurized irrigation system to increase water use efficiency is an important component of the modernization process. Water is the most critical input for agriculture. The availability of adequate water for irrigation is a key factor in achieving higher productivity. However, poor efficiency of conventional irrigation systems has not only reduced the anticipated outcome of investments towards water resource development, but has also resulted in environmental problems viz., water logging and soil salinity, thereby adversely affecting crop yields.(National Mission on Micro Irrigation)Management of the water resources for diverse uses should incorporate a participatory approach: by involving not only the various governmental agencies but also the users' and other stakeholders, in an effective and decisive manner, in various aspects of planning, design, development and management of the water resources schemes. Water Users' Association and local bodies such as municipalities and Gram-Panchayats should particularly be involved in the operation, maintenance and management of water infrastructures / facilities at appropriate levels progressively, with a view to eventually transfer the management of such facilities to the user groups/ local bodies (National Water Policy (2002))

LOCATION OF STUDY AREA

To apply design principles and consideration by select minor canal of Sardar Sarovar Canal Command this lies in Amod Taluka, Bhruch District and off taking from Ochhan distributory canal as shown in Fig-1 and Fig-2. It lies between 73°03'01''E to 73° 51'55"E East longitudes 21°59'16."N to 21°59'44"N North latitudes respectively. Length of Karena minor is 6.88 km and Total CCA area is 456 ha. PINS study area in total, Culturable Command Area (CCA) is 62.88+74.02=135.91Ha.

No. of Farmers Benefited is 71. Major Cropping pattern prefers to grow is cotton through Drip and Traditional flood Irrigation. Karena is located 34.68 km distance from its District Main City Bharuch. It is located 141 km distance from its State Main City Gandhinagar.

Fig -1 Location of study area (Source: www.mapsofindia.com.)

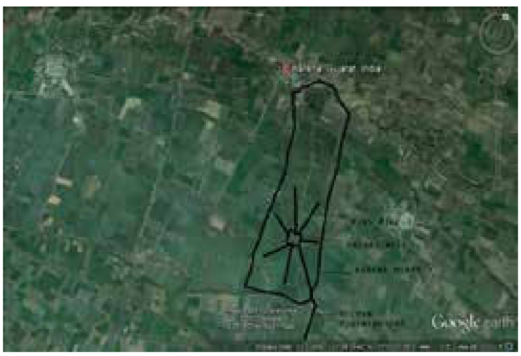

Fig-2(Location of study area in Google earth)

DESIGN OF PINS

To make the MIS adoption technically viable in the canal command areas, there is a need to have a pressurized water conduiting system in place drawing water from the canal, storing in a natural depression or a sump and further taking the water to the farmers' field, where the MIS would be in place. This would form the Pressurized Irrigation Network System (PINS) as shown in Fig-3. For establishment of PINS, power available for 24 hrs and 8 hrs has been considered for calculation purpose so as to arrive at the best option. Therefore we select chak area of 62.88 Ha and calculated component of PINS for both the alternatives.

1. Connecting Pipes

The water from the canal can be brought to the sump through gravity flow by pipelines. Assuming gravity flow non-pressure pipes (PVC (PN 2.5))

(A) Design Discharge Here BDC=Basic Discharge Coefficient (given) = 0.68 CCA=62.88 Ha

Power Supply	Discharge (Q)(lps)
24 hrs	(BDC x CCA)
8 hrs	(BDCxCCAx3) = 128.28

However, for practical purposes, design discharge for 24 hrs is increased by 1.5 times (pump operation)

(B) Find Diameter of pipe D using Hazen Williams equation:

$v = k \times C \times R^{0.63} \times S^{0.54}$ (where, k = 0.85 (SI units), C = 150 (PVC/HDPE), R = D/4 (Circular pipe), S = Gradient (H_f / L)

Power supply	Diameter=$[Q/(41.791xS^{0.54})]^{0.38}$
24 hrs	180 mm
8 hrs	315 mm

Dia. (Mtr.)	Area (sq.mtr)	Discharge (cumec)	Reqd Q for 8 hr (cumec)	Reqd Q for 24hr (cumecs)
180	0.0254	0.018	0.1499	0.0499
200	0.0314	0.022	0.1499	0.0499
225	0.0397	0.028	0.1499	0.0499
250	0.0490	0.034	0.1499	0.0499
280	0.0615	0.043	0.1499	0.0499
315	0.0778	0.055	0.1499	0.0499
355	0.0989	0.069	0.1499	0.0499

Table-1 Diameter, Area and Discharge.

2. Storage Facility

This is required for 8 hrs power supply. For practical purpose, 1 day storage facility is to be designed.

Total 1 day storage Volume

V = (BDC x CCA x 3600 x 24) / 1000 m3 =36.84 m^3
For 24 hrs. Power supply considered 0.5 hrs storage V=(BDCXCCAX0.5X3600)/1000 m^3 =76.97 m^3

Given data: G.L. at well location= 20.47 m, F.S.L. of parent canal =22.661 m Reasonable depth = 4.921 m

Dia.(m)	3	3.5	4	4.5	5.5
Depth(m)	10.89	8.0	6.13	4.84	3.24

Considering Dia. = 5.500 m
Eff. Depth of well = 3.240 m
Depth of well provided = 6.660 m **Table-2** Diameter and Depth

3. Design of PINS pipes

These comprise of the pressurized pipe network and hence use of HDPE (PN4, PE80) is recommended. Considering the Comprehensive cost of PINS and MIS, this is the major cost component and hence required to be economized as possible.

(A)Design Discharge

Power Supply	Design Discharge (Q)(lps)
24 hrs	(BDCxCCA)/2 = 5.34lps
8 hrs	(6/n) x[BDCxCCA]/2 = 2 lps

Where n = no. of sub-chaks

Gradient (TEL) may be considered between 0.3 to 0.5 %. However this should be matching with the topographical features like shape of the sub-chak and land gradient.

(B)Diameter of PINS pipe D (Hazen Williams equation)
$V = k \times C \times R^{0.63} \times S^{0.54}$ where, k = 0.85 (SI units)
C = 150 (PVC/HDPE)
$D = [Q / (41.791 \times S^{0.54})]^{0.38}$
R =D/4(Circularpipe)=140MM
S = Gradient (H_f / L)

4 .Design of Pumps

Pump HP=(Q x H)/(75 x η) =20.36 HP where,H=Pressure head in m.

$\eta = 0.7 \times 0.8 = 0.56$

Power Supply	PumpHP = (QxH)/(75x h)
24 hrs	12.5 HP/per pump = 2 Nos
8 hrs	12.5 HP/per pump = 6 Nos

H = 40 m (inclusive of suction lift of 3 m) generally considered. However can be modified as per the topographical features.

HP calculated above can be rounded to lower available HP (5, 7.5, 10, 12.5, 15, 20, 25) if exceeds nearly by 10 %.

5. Filters

It is envisaged that for the PINS projects, one primary filter (Media filter) would be provided just downstream of the pump delivery section. Provision of pressure loss of about 5 m is considered in the PINS design.

Capacity of filter(m^3/hr)=Design discharge of PINS pipe(lps) X 3.6 Media filters are available in the capacity of 25 , 40 and 50 m^3/ hr.

Secondary filter (Screen / disc filter) is proposed at the farm level.

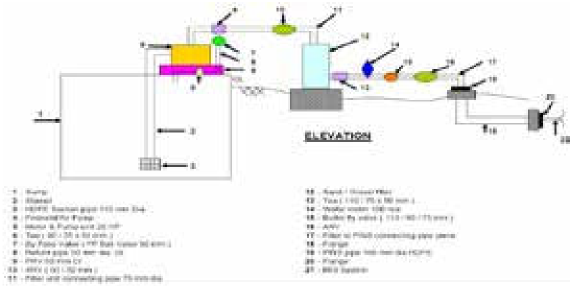

Figure-3 Elevation of PINS system (Source: Narmada Project Canal Division - 5,Karjan)

ANALYSIS AND RESULTS

As continuous 24 hrs power supply is available no storage required. Storage for 16 hrs is required for 8 hrs power supply to be created in the vicinity of pressurization (existing seam talav, natural depressions, new artificial storage – about 1200 m^2 land is required)As 24 hrs water requirement is to be fulfilled in 8 hrs possible supplies, three times pumping efforts as that of requirement in 24 hrs supplies necessary. This happens to be the most likely ground level condition covering predominant command area.

Data Given: Basic Discharge Coefficient (BDC)=0.68, K=0.85, C=150, G.L. at well location 20.47 m, F.S.L. of parent canal 22.661 m

Data	For Power Supply	
	8 Hrs.	24 Hrs
Discharge(Q)	128.28 lps	42.76 lps
CCA	62.88 Ha	62.88 Ha
Diameter(D)	315 mm	180 mm
Velocity	0.7 m/sec	0.7 m/sec
Area(m3)	0.2199 m2	0.0.0733 m2
No. of rows	1	3
Storage Facility	36.84 m3	76.97 m3
PINS Pipe(by pressurized flow)	140 mm	140 mm
No. of pump reqd.	6 Nos.	2 Nos
Suction Head (H)(Assume)	40 m	40m
Length of PINS pipe (measure by map)	335.62 m	335.62m

Table:3 Design of PINS

CONCLUSION:

PINS are substitute arrangement for sub-minors and field channels in an open cannel network. This is primarily a pipe network carrying required discharge at adequate pressure, finally delivering it to the attached MIS network. Design of this network is suitably framed incorporating features of water distribution under SSP Command. Also find irrigation efficiency at given discharge. Similar work can be done by considering other crops. Same design can also can be concluded from the study that shifting to pressurized irrigation in commands of flow based minor irrigation systems in plateau areas is feasible both from technical and financial point of view. The system reduced the turbidity of the water and provided continuous supply of water so that pressurized irrigation systems can be used with the canal irrigation system. The system has good potential of adoption in areas where the demand of water for non-agricultural sectors is going to rise sharply. Since the initial capital cost is higher, the funding mechanism needs to be developed in view of social, ecological and economic benefits.

ACKNOWLEDGMENT

The Authors are thankful to Mr.Arun Viramgama, Netafim head office, Vadodara and Mr. A.P..Ganpate, PINS Cell, SSNNL, Gandhinagar and Mr.Y.M.Modi, Mr.P.R.Soni, Canal Division Circle-5 Karjan for providing necessary data and guidelines in carrying out this study.

REFERENCES

R.C. Srivastava et al. India. In: Proc. nat. seminar on micro-irrigation research in India: status and perspectives for 21st century, 27–28 July, 1998, Bhubaneswar, pp 90–95 | Srivastava RC, Mohanty S, Singandhupe RB, Biswal AK, Ray LIP, Sahoo D (2006) Studies on canal water based pressurized irrigation system in a minor irrigation command. J Agric Eng 43(4): 28–35. | "Administrative & Technical Guideline for preparation of PINS System "by PINS Cell, SSNNL.1-25 | Arora, K.R. (2004). "Irrigation, Water Power and Water Resource Engineering." Standard Published Distribution. | Shekinah E.S. et al.,(2011) 'Conventional and Micro irrigation Systems in Sugarcane Agriculture In India. 'Sugar Tech 13(4):299-309. | Srivastava R.C.et al.,(2010)'Feasibility Evaluation of Pressurized Irrigation in Cana Commands. Water Resource Manage24:3017-3032 | "Project report on PINS" Narmada Canal Division Circle-5, Karjan | Phocaides A., (2000) 'Technical Handbook on Pressurized Irrigation techniques'. Published by Food and Agriculture Organization of the United Nations. | Shah et. al (2009) "A case for Pipelining Water Distribution in the Narmada Irrigation System in Gujarat,India".International Water Management Institute(IWMI) publications 1-25. | Singh H.P.et al.,(2001) "Micro-Irrigation "published by Central Board Of Irrigation Power. | JADAV P.S."Mordnization of Canal Command Area through Adoption Of Piped Network/OR/Micro Irrigation Systems". Water and Land Management Training Research Institute, ANAND.1-20 |