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Modernization of Kakrapar Right Bank Main Canal

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***Abstract*:** *For development of irrigated agriculture in the Tapi basin, Ukai-Kakrapar Scheme, one of the biggest irrigation scheme in Gujarat, was taken up by the Government of Gujarat. Tapi is one of the largest rivers in central India which flows west-ward and discharges into the Arabian Sea. The present project work has been taken to study problems in existing unlined Kakrapar right bank canal of Kakrapar project. Kakrapar weir is located on river Tapi in village Kakrapar of Mandvi taluka of Surat district. As increased in demand-of food and fodder, demand of water for irrigation is also increasing In unlined canal high velocity cause erosion and heavy seepage loss leads to water logging problems in surrounding area. These problems can be solved by canal lining. Both these reasons have reduced the availability of water to the farmers. With modernization of canal one has to take into consideration the existing cross drainage or regulating structures on existing canal has also to be redesigned. Detail economic analysis is also done giving effective measures to reduce the cost. Thus to improve the efficiency of the canal network, modernizing existing canals has become need of the hour.*
Keywords: *canal lining ,modernization, Tapi basin, weir.*

I. Introduction

Canals have played an important role in creating assured irrigation supplies to agricultural fields and contributed substantially to the green revolution in the country .Once the water for irrigation was made available, the crop pattern also changed and hence demand for the irrigation water has also increased. Also people preferred the crop which can give higher return i.e. sugarcane and other cash crops. The construction was completed in 1954 for the purpose of Irrigation of Gujarat state. The area of catchment is 59904 km^2.It is divided into two main canal i.e Kakrapar Right Bank Canal (K.R.B.C) and Kakrapar Left Bank Canal (K.L.B.C). The length of both canal are 64 km. K.R.B.C has capacity of 70.23 m^3/sec having Gross Command Area of 100220 ha. and Culturable Command Area of 58745 ha. K.L.B.C has the capacity of 85.63 m^3/sec having Gross Command Area of 247000 ha. and Culturable Command Area of 145335 ha.Thus to increase the discharge carrying capacity, velocity of flow is to be increased. But in unlined canal velocity should be kept low (non silting non scouring velocity), and hence the overall discharge carrying capacity was not in accordance with the existing demand This problem can be solved by providing lining. **Stuart Styles,et.al(2006),** state that Modernization of the facilities to date expected to help the district improve flexibility of operation for the farmers and to decrease pumping costs for the district. **Adhau S.(2009),** had studied eight case studies of micro hydro plants in rural area of India . Modernization of hydraulic regulation of irrigation canals is a proven method to increase the hydraulic efficiency of irrigation projects, from below 40% for old traditional irrigation canals up to more than 90% for modern systems with automatic control algorithms.

A. Objectives of Lining:

- To deliver assured and equitable supplies of canal water to the farmers by making the channels capable of taking their authorized discharge.
- To reduce incidents of frequent eroding, cuts and breaches of canal banks.
- To reduce seepage in the areas where water table is quite high thereby reducing water logging.
- To improve operational efficiency and to reduce operational and maintenance cost.
- To improve the working of problematic channels suffering from frequent silting, scouring and chronic shortage at tails and also having operational draw backs.

B. Scope of Study:

The velocity of water in the canal will increase as the surface of the canal will be smooth. In unlined canal the velocity which is non silting, non scouring is lower which increases in lined canal, increasing the discharge carrying capacity. Also in normal circumstances the slope of the canal is gentle compared to slope of existing ground. Thus to maintain the canal section in partially cutting and partially filling, at regular interval canal drops are provided which will dissipate energy through the formation of hydraulic jump. In unlined canal this is a

common practice where loss of energy is taking place and attempt is to be made to derive energy from this source. At these points micro hydropower generators can be proposed.

C. Seepage Analysis:

The principal factors affecting seepage from an earthen canal are nature of soil material, **deposition** of silt, groundwater table with respect to canal water surface, depth of water in canal, hydraulic conductivity of the soil, inflow seepage water and chemistry of the soil and water. Quantitative knowledge of seepage losses can be obtained by direct measurements, or by indirect methods. From an unlined Kakrapar right bank canal sample was collected .Direct measurements of seepage by determining coefficient of permeability of field samples in laboratory was performed and observing the water table profile in the field from which seepage loss rates were computed by knowing the requisite aquifer characteristic which has shown that lining of canals in the study area will save about 34.16 % of water which otherwise is going waste for various reasons described above. The saving of water by lining will enable the project to facilitate the irrigation in additional area. This will also solve the problem of water logging in the initial stretch of canal where excessive use of water by farmers and seepage.

D. Economic analysis :

Once it is decided to provide lining the nature and components of lining has to be decided depending upon the soil properties and especially seepage though it. It is observed that the soil in this region is having the combination of black cotton soil and yellow soil. If the lining alone is provided having the thickness of 10 cm in M 15 grade concrete, differential settlement can take place which can develop cracks in lining. It requires strengthening in the form of reinforcement. To take care of it, it is proposed to provide geotextile TF41 whose specification is given below and which is successfully used in UP and Bihar. The same material is used under foundation in many residential project in Surat also. To calculate the cost of lining the total length of 60.980 km of canal is divided in 10 parts as shown in the table as the cross section is varying. It varies from 92.191 sq m to 53.843 sq m with wetted perimeter ranging from 37.896 m to 26.179 m and discharge ranging from 92.095 cumec to 78.340 cumec. The total requirement of lining calculated as shown in the table is 2032735 sq.m. From the SOR of Surat Irrigation Circle, it is found that lining of 10 cm thickness will cost Rs.427 per sq.m. However the geotextile which is also to be used with it, an additional cost of Rs.60 per sq m will bring the cost to Rs.487 per sq m. Thus total cost of lining alone comes to Rs.989941945. To this other cost is added the total cost of lining comes out to be Rs.1182195309.The objectives were to study how Benefit derived and Cost incurred in the project can be worked out. Thus benefit-cost ratio is to be studied in addition to technical feasibility and economical viability.

II. PROJECT ECONOMIC EVALUATION

A. Analysis of Project Cost :

	GENERAL ABSTRACT		
	Item of Work	Unit	Amount
A	Preliminary	Rs.	
B	Land	Rs.	
C	Work	Rs.	
	Dewatering the foundation trenches during excavation of canals, drains, foundation trenches, concrete, masonry etc. Till completion and diversion of surface and sub surface water by using pumps of suitable capacity either diesel or electrical driven including cost of labor, pipelines etc. For delivery distance beyond 50 meters.	Rs.	288567.00
	Dismantling the existing stone masonry and brick masonry including sorting out and stacking of useful materials and removing the debris and making good damage etc complete as directed in cement mortar.	Rs.	385552.00
	Clearing the canal land width including removing the trees up to 0.50 meter girth, bushes, shrubs etc. Including depositing the materials outside the canal land width as directed etc. Complete.	Rs.	3207996.00
	Excavation for foundation in all sorts of soil including sandy and gravelly soil, soft murrum including depositing the excavated stuff as and where directed including back filling the trenches with suitable excavated stuff etc. Complete for lead up to 50 and lift as under.(manually without dewatering)	Rs.	24805293.00
	Excavation of canal/drain in all sorts of soils (including wet and slushy condition of soil) including yellow, sandy and gravelly soils & soft murrum including depositing the excavated stuff in uniform layers in canal banks or in spoil banks or as and where directed including dressing the canal section up to lead of 50 meter and lift shown below including clearing the site, dewatering etc. Complete. (manual operation with dewatering)	Rs.	27105979.00
	Excavation of canal/drain in soft rock depositing the excavated stuff in uniform layers in canal banks or in spoil banks or as and where directed including dressing the canal section up to lead of 50 meter and lift shown below including clearing the site, dewatering etc. Complete. (manual operation with dewatering)	Rs.	10014489.00
	Earthwork in embankment using selected soil, soft & hard murrum excavated from approved borrow area/village tanks etc. including breaking clods, dressing to the design section with	Rs.	53618965.00

	lead up to 1.0 kilometer and all lifts**.(by poclane machinery)**		
	Compaction of earthwork in embankment in layers 15 to 20 cms at requisite moisture content to required dry density not less than 85% of corresponding proctor maximum dry density including watering, rolling with suitable type of roller etc. Complete.	Rs.	8661864.00
	Excavation of canal/drain in hard rock, including blasting, depositing the excavated stuff in uniform layers in canal banks or in spoil banks or as and where directed including dressing the canal section and sorting out useable rubble and stacking regularly as and where directed including dewatering if required etc. Complete for lead up to 50 meter and lift shown as below etc. Complete (by machinery) (for qty. More than 1,00,00 cm)	Rs.	167948.00
	Providing and fixing PVC heavy duty water stops in barrels through and wing walls with 25 mm wide expansion joint as shown in drawing including filling in joints asphalt, pad or bituminous or cork board of approved quality.	Rs.	36404283.00
	Trimming of the canal section manually for preparing sub grade for laying cement concrete.	Rs.	27592428.00
	Providing and laying plain/reinforced cement concrete of cement, sand and metal (20mm to 25mm size) in following proportion laid in situ including centering, shuttering, temping, smooth finishing, curing etc. Complete as directed for all leads and lifts		
	(a) M-15	Rs.	989941945.00
	Total	Rs.	1182195309.00
	Add 2% W/C Est. & Contingencies	Rs.	23643906.00
	Add 1% Quality Control	Rs.	11821953.00
	Add 1 % For Guj. Bld. & Cons. Walfare Cess	Rs.	11821953.00
	TOTAL	Rs.	1229483121.00
	SAY	Rs.	122.95 Cores

B. Benefits Derived from the Project

Name of crops	Present yield and production			Max yield and production after completion of project			Additional Production	Production income difference	
	Area in HA	Yield in Qtl./Ha	Production in Qtl	Area in HA	Yield in Qtl./Ha	Production in Qtl		Rate / Qtl	Amount Rs. in Lakhs
1	2	3	4	5	6	7	8	9	10
Sugarcane	31530	750	23647500	32629	825	26918925	2364750	170	4020.08
Paddy	15560	25	389000	15835	25	719775	330775	750	248.08
Vegetables and others	11000	85	935000	11550	85	1785000	85000	650	552.5
								Total	4820.66

C. Benefit-Cost Ratio:

(A) Benefits

(A-1) Direct Benefits

(i) As per statement — 4820.66 Lac

(A-2) Indirect Benefits

(ii) Reduction in salinity and water logging ……

(iii) Reduction in seepage and leakages ……

(iv) Employment to farm labour ……

(v) Increase of land value ……

Total annual benefits (i) to (v) — 4820.66 Lac

(B) Annual Cost

(i) Capital Cost

(a) Construction cost — 12295.00 Lac

Total Cost — 12295.00 Lac

(ii) Interest @ 10 % on capital cost — 1229.50 Lac

(iii) Depreciation charges @ 2 % on capital cost — 245.90 Lac

(iv) Operation and maintance charges @ 15 % on capital cost	1844.25	Lac
(v) Total annual cost (ii)+(iii)+(iv)	3319.65	Lac

Therefore B/C ratio = Total annual Benefit / Total annual cost
4820.66/3319.65

B. C. Ratio = = 1.452

As in the above project the Benefit/Cost ratio comes out to be 1.452 the project can be taken up as it is economically viable in addition to its technical feasibility.

III. CONCLUSION

- As the quantity water in the reservoir is adequate, the conveyance and distribution of water has to modify. By providing lining, not only seepage can be reduced, but it will also minimize the problem of water logging. Whatever quantity of water saved can be used for irrigation.
- Also the rugosity co efficient is improved and velocity can be increased. This will increase the discharge carrying capacity of the existing canals as Discharge Q=Area* Velocity. This will reduce the problem of land acquisition for increasing the capacity of canal.
- Also due to lining of canal, the head loss can be reduced. In this case, instead of providing canal drops, mini hydro power plants can also be thought of if it is technically feasible and economically viable.
- If required the existing structures along the canal alignment can be modified.

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References

[1]. David C. ROGERS; Teaching canal hydraulics and control using a computer game or a scale model canal; hal-00468553-31. (2010)
[2]. [2] Garg S.K, Irrigation And hydraulic structure by Khanna Publishers. (2006)
[3]. Indian standard Code IS 10430-2000 : Criteria foe Design of lined canals and Guidance for selection of type of lining.
[4]. Indian standard Code IS 3873-2002: Laying cement concrete lining on canals
[5]. Indian standard Code IS 9698-1995: Lining of canals with polyethylene film.
[6]. KHAN M.N.et.al, Impact of Watercourses Improvement in the Upper Chenab Canal System of Punjab, Pakistan, INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY ,pg. 1560–8530/2001/03–2–192–194 ,http://www.ijab.org.
[7]. Manuel Rijo et.al, Supervision and Water Depth Automatic Control of an Irrigation Canal, Journal of Irrigation and Drainage Engineering, Vol. 136, No. 1, January 1, ©ASCE, ISSN 0733-9437/2010/1-3–10. (2010)
[8]. M. El-Kady, H. Wahby, John W. Andrew- A technical report on Lining Of Egyptian Canals Techniques And Economic Analysis.
[9]. Omar F.D. ,Modernization of irrigation systems with canal automation in Turkey by, Aduziraat fakiiltesi Dergis;6(2):69-79. (2009)
[10]. Phadnis S. S. et.al, Participatory approach for socially and Environmentally Sustainable Modernization of Existing Irrigation and Drainage Schemes in India, INTERNATIONAL JOURNAL OF ENVIRONMENTAL SCIENCES Volume 1, No 2. (2010)
[11]. Tarek Rabbani, "Flatness-based control of an irrigation canal using SCADA", published in IEEE Control Systems Magazine, 29(5), 22-30. (2009)
[12]. V.T. Chow- Open channel Flow.
[13]. www.gov-gujarat.com
[14]. http://www.gidb.org
[15]. www.engineeringtoolbox.com