



REINSTALLATION OF FUSEGATES AFTER FUSING ON WANAKBORI WEIR (GUJARAT)

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ABSTRACT

In present research study, Reinstallation of Fusegates after Fusing on Wanakbori Weir (Gujarat) has carried out. Government of Gujarat (GOG) has implemented this innovative Fusegate technology on 12 irrigation schemes through Hydroplus International – FRANCE. Out of these 12 dams, Wanakbori Weir (Gujarat) experienced fusing of Fusegates due to heavy flashy flood. It found that no other such incidence observed till date. But, in 2006 flood experience few numbers of gates fused and till date authority don't reinstall these fused Fusegates on weir. This study gives information about reinstallation of Fusegates on Wanakbori weir. After installation of Fusegates, reservoir storage capacity increased, increased command area, change occurred in cropping pattern, increased driving head and thereby increased canal capacity and firming of irrigation. Fusegate system can raise Full Reservoir Level, Storage capacity and Spillway discharge capacity without affecting Maximum Water Level and additional submergence. This system proved best alternative compare to other gate system. It found cheaper in long run if fusing of Fusegate phenomenon does not occur early. Where fusing phenomenon occurred in Wanakbori weir, and facing problem of again Ungated system on that weir, but in that case also Fusegate system worked exactly according to predetermined design to save dam, downstream lives, property, cattle and farming. After fusing of fusegates all this benefit were reduce and loss of money by crop production. This research paper gives information on before and after fusegates its benefits and losses. So, this study will suggest GOG to reinstall these fused Fusegates and future losses will reduces by reinstallation of fusegates on Wanakbori weir.

KEYWORDS : Fusegates, spillway, flood, weir, discharge, fusing, storage, reinstallation, benefit cost ratio.

DEVELOPMENT OF FUSEGATE SYSTEM

Fusegate Technology has been emerged from the Submersible Fusing Gates. Hydroplus International, France in 1991, patented it. Francois Lemperiere invented original system of submersible Fusegates in 1989 in France. Hydroplus International Company established in 1991 to develop and operate the Fusegate device. HYDROPLUS® Fusegates™ received trademark and patented in 1991



- ® Registered Trademark of Hydroplus S.A.
- TMPatent trademark of Hydroplus S.A.

Hydroplus International experimented this innovative technology of Fusegates on Lussas Dam near Aubenais in South-Central France in the year 1991. Reservoir filling successfully accomplished and sufficient water for crop-irrigation received in the very first year. In India, this Fusegate System was first implemented in Gujarat state on Wankbori weir (Mahi Stage-1) Ta: Balasinor, District: Kheda in the year 1994-1995 GOG received National Productivity Award for this irrigation project in the year 1995.

OBJECTIVES

- 1) To study Fusegates as fusible elements by technical point of view.
- 2) To study Performance of Fusegates system on different irrigation projects in Gujarat (India).
- 3) To study Benefit and cost (losses) of reinstallation of Fusegates.
- 4) To study feasibility of reinstallation of fused Fusegates

METHODOLOGY

- Literature search on Fusegate schemes in Gujarat from various GOG offices.
- Visits to GOG offices and approachable project site on which Fusegates installed.

- Data collection from various irrigation projects on which Fusegates installed.
- Analysis of collected data and conclusions from it.
- Recommendations for Reinstallation of fused Fusegates on Wanakbori weir.

WANAKBORI WEIR (MAJOR IRRIGATION SCHEME) WHERE, U/S CONTROL POINT IS PRESENT

Mahi Irrigation is situated in Kheda district, the most advanced district among all 22 districts of Gujarat state. This project is completed in two stages. The stage – I comprised of a Wanakbori pickup weir on Mahi river near village Wanakbori of Balasinor Taluka, District: Kheda in Gujarat State. Weir is completed in the year 1959 and stage – II program, a multipurpose Kadana dam project, Diwada colony, Taluka, Santrampur, Dist., Panchmahal completed in the year 1979. Kadana dam is considered to be a one of the largest dam in India which provides irrigation, generates hydropower and acts as flood protective reservoir. (Mahi Stage-II) Kadana dam is nearly 70 km. away from the upstream side of Wanakbori weir (Mahi Stage-I). In the year 1958, Wanakbori weir project was irrigating 1,00,000 ha. before Kadana dam program in the year 1979, 2,12,694 ha. Perennial irrigation has been created but the capacity was envisaged 2,60,000 ha. It indicates that there was a scope for more potential irrigation increase. Moreover, availability of water was more and utilization of water for irrigation was less.

CASE STUDY

Wanakbori weir is equipped with 33 independent. Free standing concrete fusegate units. 20-meter-wide and 2-meter-high comprising each one pressure inlet well in its center. The total length of spillover is 673.608 m. the total length of fuse gate is $22 \times 33 = 660$ m. So the 13.608 m remaining length as the weir about 6.80 m long on each extremity, is equipped with fixed concrete element without well. The increase of the weir crest level by 2 m allows an extra storage of 900 Mcft. and also an increase of the discharge capacity in the irrigation main canal by increasing driving head. The 33 fuse gates will remain stable for reservoir level up to 75.25m (242.82') this allowing to control of a flood of about a 50% of the design Flood. For the higher discharges the elements will fuse progressively. The 33 fuse gates will overturn for an upstream reservoir level of 76.55 m. (251' i.e. designed HFL). According to the stability analysis a bottom width of 2.60 m is kept for the elements tilting first. This bottom width is increased to 2.80 m. for elements tilting the last, by adding a downstream footstep 0.20 m wide. The upstream levels for fuse gates turnover is ranged from

75.25 to 76.55 m. Only one element will tilt over, for the three first rotating levels. Sets of 3 or 4 fusegates will tilt over at the same time for the other rotating levels. So by monitoring flood control with upstream reservoir of Kadana & Panam.

ANALYSIS OF DATA

Compare Details Before and After Installation of Fusegates

This paper comprises of analysis of available collected data from various Government offices. It is included the comparison of discharge before and after fusegates system. Comparison of U/S R.L before and after fusegates system, comparison of storage before and after fusegates system, comparison of irrigated area before and after fusegates system, comparison of crop production in tonnes before and after fusegate system, comparison of crop production in Indian Rs and calculation of benefit cost ratio from available data for before and after fusegates system.

Reservoir details - before and after installation of Fusegate system

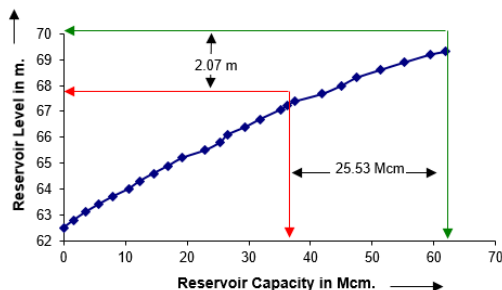
Below Ttable., I indicate Reservoir details before and after installation of fusegate system like gross storage capacity and effective storage capacity etc.

Table.1 Reservoir details after installation of fusegate

STORAGE CAPACITY IN Mcm	INCREASE IN STORAGE CAPACITY IN Mcm	AFTER REHABILITATION % INCREASE IN STORAGE	Remarks
GROSS LIVE			
G 67.45 L 67.78	+25.51	70.43%	Significant

Graph 1,2,3,4,5,6 and 7 shows capacity curve of Wanakbori weir. In X-axis indicate reservoir capacity in Mcm and Y-axis indicate reservoir level in meter. Graph shown at 2.07 meter height storage increase 25.53 Mcm.

**Capacity Curve (Wanakbori weir)
FG. Ht. 2.0 m**



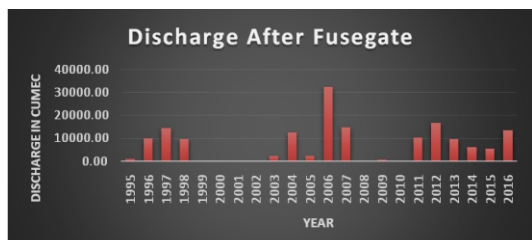
Graph no.1 Capacity curve for Wanakbori weir

Discharge Before Fusegate



GRAPH-2

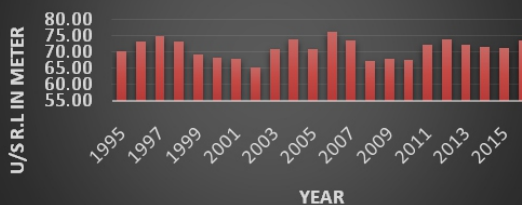
Discharge After Fusegate



YearWise U/S RL Before Fuse gate



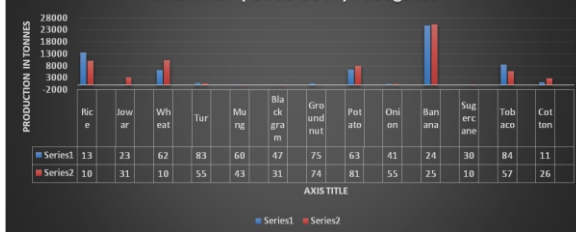
YearWise U/S RL After Fuse gate



Fused gate R.L



Production of Crops Before (1991-1996) and After (2001-2006) Fusegates



Benefit cost ratio

No negative downstream impact after flood on the system. Achieving similar results in any other manner would have required the construction of 20 dams of average size. The Fusegate system has augmented the discharge carrying capacity of the main canal of Mahi project to its designed value. Capacity of the main canal augmented 161.29 to 215 Cumec. Sometime it has gone up to the 237.69 Cumec. This resulted into additional irrigation of 25669 ha. This has provided dependable and reliable irrigation facility to the tail areas, which were earlier having either no irrigation or erratic irrigation. Nearly 40,000 ha. Area has received the advantage of firming up which were formerly erratic or under irrigation. Moreover, paddy crop production achieved in 12000 ha. In addition, 29,000 ha. Of (Shedhi/Mashwo) received the irrigation facility even in Kharif season on total C.C.A. 186235hectare of M.R.B.C. project.

TABLE-2 Installation of Fusegate: Benefit Cost Ratio

Crop	Area Ha.	Yield Before Kg.	Yield after in Kg.	Difference in physical in Kg	Product ion in value Rs.	Price Quintera l	Product ion in value Rs.
Rice	13	23	62	83	60	47	75
Jawar	10	31	10	55	43	31	74
Wheat	62	83	60	47	75	63	41
Tur	83	60	47	75	63	41	55
Mung	60	47	75	63	41	55	25
Black gram	47	75	63	41	55	25	10
Groundnut	75	63	41	55	25	10	57
Potato	63	41	55	25	10	57	26
Onion	41	55	25	10	57	26	
Banana	24	30	84	11			
Sugercane	30	84	11				
Tobacco	84	11					
Cotton	11						

1	2	3	4	5	6	7	8
BANANA	1000	70000	75000	5000	10500	210	105
PADDY	16000	2500	3500	1000	4000	400	640
BAJRI-K	3000	1500	2000	500	1500	300	45
WHEAT	8000	1700	2700	1000	4000	400	320
TOBBACO	5000	2000	2300	300	1500	500	75
MUSTER	2000	1500	2000	500	4000	800	80
BAJRI/O.	5000	0	2000	2000	7000	350	350
TOTAL	40000						1615

- AVERAGE PER HACTARE
- GROSS VALUE OUTPUT IN
- Rs. 4037.50 X 40000 = 1615 X 105
-
- Net value output in Rs.2462.87 x 40,000=985.15 x 10⁵
- GROSS B-C RATIO= 1.882
- NET B-C RATIO = 1.148

(DATA OF PRICE PER QUINTAL COLLECTED FROM AERC SCHEME)

Table 3. Benefit Cost Ratio –Anticipated and after installation of Fusegate

Sr. No.	Crop	Anticipated Area in ha.	Production value in Rs. /ha.	Production value in Rs. lacs	Actual irrigated 1995-96	Production value in Rs./ha	Production value in lacs
1.	Banana	1000	10500	105	958	10500	100.59
2.	Paddy	16000	4000	640	19482	4000	179.28
3.	Bajri-K	3000	1500	45	3577	1500	53.66
4.	Wheat	8000	4000	320	3351	4000	134.64
5.	Tobacco/Cotton	5000	1500	75	1766	1500	26.49
6.	Other seasonal Muster crops	2000	4000	80	2044	4000	81.76
7.	Sugarcane	5000	7000	350	1245	7000	87.15
	Total	40000 ha.		1615 lacs	32423 ha		1262.97 lacs
		Benefit: 1615 lacs Cost: 858 lacs B/C=1615/858=1.88>1			Benefit: 1262.97 lacs Cost: 858 lacs B/C=1262.97/858=1.47		

Production value in Rs. /ha kept same for anticipated B/C and for actual B/C calculation. To give weightage on food production rather than increase in price. It seems from the above table that anticipated benefit cost ratio for Fusegate installation was equal to B/C=1.88 and actual benefit cost ratio after installation of Fusegate is B/C=1.47. This is not the extension or revision of the project but this is a need, which raised out of change in crop pattern, crop water requirement and design parameter. Benefits availed due to the Fusegate system is high. This is due to the nature of economics of irrigated agriculture which starts from the very next year.

CONCLUSIONS

Conclusions of the performance of Fusegates before installation, after installation and after fusing on Wanakbori weir are as under:

- Fusegate increases Full Reservoir Level, Live Storage Capacity and annual irrigation without affecting MWL on wanakbori weir.
- Due to installation of fusegates dependable storage increases which can be used for assured irrigation supply, which earlier was nil or erratic.
- Whole region will benefit due to installation of Fusegates, without expenses on major civil works, except minor maintenance and modification in canals. This will result in overall economical and time saving solution.
- Although there may be some possibilities of submergence due to installation of Fusegate however it will not be appreciable compared to increase in annual irrigation and its dependability.
- Reinstallation of Fusegate will recover the storage capacity of dams hence loss of storage due to fusing of fusegates and silting

can recovered to greater extent without much expense on desilting etc.

- Reinstallation of fusegates will benefit not only Kheda district but also other part of the Mahi irrigation command during scarcity year.
- Rainfall is erratic and unevenly distributed in Gujarat. Sometimes maximum daily rainfall is as high as half of the total rainfall in such situation, this maximum rainfall can be possible to store after installation of Fusegates by avoiding wastage of water.
- From analysis it is found that reinstallation of Fusegate justifies the cost effectiveness of the system.
- Fusegate does not require replacement of seals and anticorrosive paint thereby proved economical long-term maintenance.
- Fusegates installation is easy and rapid hence it proved the fast and effective solution in water scares condition, which becomes acutely sever in period before monsoon, in most of the dams.
- Fusegates are flexible structures and no effect noticed regarding deformation, displacement of gates on weir from earthquake on dated 26th Jan – 2001, hence its reinstallation can considered as safe by the aspects of earthquake forces.
- Fusegate fuses during heavy flashy flood to save earthen dams, downstream lives, properties, cattle and farming. Fusing of fusegates one after another planned to avoid sudden rise in out flow. In 2006 Fusegate fused exactly as per predetermined water level and fusing flood keeping earthen dam safe during/after flashy flood, hence their reliability and safety of operation during high spillage proved.
- B/C ratio for after installation of fusegate is more than before installation of fusegate indicating increased in overall benefit.

RECOMMENDATIONS

It has been recommended that

- Fusegate system should used on all irrigation schemes where possible to increase the potential of water use and water storage especially in Gujarat region of scares rainfall without increase in MWL and additional cost of constructing major civil works.
- Dam owner should set limit of safety margin somewhat greater than their actual requirement for flood absorption for respective projects (between crest of spillway and MWL of dam).
- Less number of Fusegates should be reinstall on weir which having large width of river gorge portion. They should keep more fixed portion at end and in between of Fusegates without affecting the afflux, backwater effect and designed flood routing.
- For receiving the longer benefits from Fusegate system, it is necessary to install the Fusegate on such a dam, which has v/s control, and/or with combination of auxiliary spillway. So, the fusing phenomenon can be avoided permanently after raising FRL.
- Fusegate system is not feasible where,
- Catchment having steep topographical configuration like reefs and out crops on upstream of weir
- Flashy rivers near coastal area.
- Bed local approach channel.
- Designer has to verify the data as listed above recommendation no.5 before ensuring the validity for the designing of the Fusegate system. Designer should invariably visit and collect the actual information from the dam site to crosscheck the supplied data.
- Innovate the Fusegate technology, which should keep the Fusegate intact after fusing so that it can reutilized with lesser expense. For Example: - catcher chain fix in base of Fusegate.
- Install the Fusegate, which made of hot-dip-galvanized iron, so that after fusing event they can reused.
- Designer should provide roller cableway system to the dam. Therefore, after fusing of Fusegate reinstallation can done easily and made dam capable for next crop season for irrigation purpose.

USEFULNESS OF RESEARCH

After referring this research paper, Government of Gujarat dam authority would decide for reinstallation of tower type fusegates system. Moreover, benefits and technology of fusegate system well explained and discuss.

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