GATES AND OPERATING EQUIPMENT FOR EFFICIENT WATER MANAGEMENT

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ABSTRACT

Sustainability and environmental compatibility should be central in the planning and implementation of contemporary water resources projects. Economically optimum performance of these projects should flow from efficient water management through various features embedded in water developmental schemes involving storage, diversion or use of ground water. While critics are arguing over the efficacy of surface flow irrigation from the storages and adverse effects of submerging large land areas, concerns for the efficient water management are undeniable. New projects are required to be planned and developed with a pragmatic outlook and have to suit the overall surroundings, including socio-economic conditions of the project affected population.

Overall planning of the WRD project should aim at efficient water use through judicious planning of all project components like storage reservoir, spillways water conductor systems etc. through a set of efficient control mechanisms consisting of different types of gates, hoists and their appurtenants.

Over the years, gates and their operating equipment are being planned, designed and fabricated on traditional lines using conventional approach. Some of the types of gates, hoisting mechanisms and basic materials used in older projects are no longer preferred due to various shortcomings associated with them. Recent years have seen many advances in the material technology, operational systems and data transmission and management. Adoption of these new age factors will result in the optimal and efficient management of precious water resources.

This paper reviews the present scenario of the hydro-mechanical and operating equipment, particularly in India, and suggests the desired changes in the approach from planning to implementation.

1. INTRODUCTION

Projects intended for use of precious Water resources for the benefit of mankind are planned and implemented from historic times during different civilizations considering the socio-economic and demographic needs of relevant periods. Ancient scriptures, cutting across religeo-political and intercontinental boundaries emphasised and stressed upon the importance of conservation of water through efficient management. During different ages, these projects were planned and executed as per the technologies and resources available at the disposal then. Early techniques mostly hinged upon harnessing of water for drinking and irrigation. For this storages were created in the form of tanks and natural depressions in the ground for collecting rain water which could be carried through channels[(1)]. In some parts of this country such systems still prevail and are adopted by the water users. These arrangements were generally without any control creating the storage behind solid barriers of earth, masonry or concrete mortar. Use of metallic gates for control of water through them was introduced later following advances in metallurgy and welding technology mostly in early twentieth century.

Recent times, particularly last century and first decade of this century has seen a spectacular demand for water which includes irrigation for the enhanced crop water requirements, drinking and lifestyle needs, industry, thermal and hydro-power. Increase in the world population and particularly that of developing countries has rendered water availability per capita at very low values. It is projected that India will have of per capita water availability of 1140 cum/year by 2050 approaching the water starved value of 1000 cum/year[(2).] This is set to fall further owing to the population pressures worldwide. Many areas are likely to be water stressed and threats of water riots are looming large due to the scarcity. India is currently witnessing an acute water shortage in peninsular region.

To optimise the use of water and improve the water availability to all the user groups in a sustainable basis, our water resources projects need to be developed and operated in a manner which will be resulting in long term reliance through efficient water management involving sound practices and elements of sustainability.

Water resources development projects are traditionally grouped as under:

- Storage such as dams
- Diversion projects like barrages and weirs
- Hydro-power projects like surface and underground power houses
- Navigation channels
- Groundwater exploitation for agriculture and domestic needs
- River interlinking projects combining storages and diversions

Successful performance from such projects is possible only when they deliver water satisfactorily for the targeted users at required time with desired quantity equitably. Though these projects are meant to last for a designated life, in reality, we observe that projects which are planned and executed by adopting inclusive and efficient parameters of planning and construction are likely to provide service for many years than the planned life. Some projects may continue to function satisfactorily even for perpetuity. But on the other hand, some may exhibit underperformance within few years of their commissioning.

Efficient water management through water resources projects depends largely on the basic planning adopted and the mode of operation. Controls for water provided therein play a vital role therein.

It has been always an endeavour of the planners and designers to perform exhaustive studies involving various alternatives relating to hydrological, geological, geotechnical, seismic and environmental parameters for developing an optimum layout and civil design of water resources projects. Much emphasis is provided to carry construction of civil components with due diligence and exercising stringent quality control norms. Quite often meticulous operation of the project is also planned to cater intended benefits within constraints. However, such balanced and articulate approach is found missing while planning and providing gates and their operating equipment at various locations in project(s) which are generally decided on a traditional set of procedures. Few incidents related with commissioning and operation of the projects has revealed some inadequacies in respect of planning and design of gated controls. In India there is need to have a re-look into our practices in this regard after having experience of constructing nearly 5000[3] large dams and developing about 47000 MW of hydropower and many minor works, after independence[3] to have sound and efficient design and layouts for the future projects.

2. OVERVIEW OF INDIAN PRACTICES

In Indian conditions, dams and barrages are equipped with spillway gates of either vertical type or radial types being operated by wire rope types of hoists. In some recent installations hydraulic operators are also chosen. Other equipment depends on the type of project and may consist of regulating gates for sluices, Intake bulkheads draft tube bulkheads , flushing gates for sluices and so on. Generally maintenance of gates is planned through either stoplogs or wheel mounted bulkheads.

Prevailing practices regarding various control equipment are as under:

(i) For a storage dam, spillway gates are either provided of vertical lift type or radial type. Generally these gates are metallic having components of different grades of steels.

(ii) Diversion weirs or barrages are mostly provided with vertical lift gates due to low height of water surface above the river beds. Of late, some weirs are also provided with radial gates due to economy and operability considerations.

(iii) For maintenance or guard purposes, either bulk heads comprising various units placed over one another or a single piece gate is provided.

(iv) Hydro-electric power plants are equipped with a variety of gate equipment ranging from radial gates at surface as well as deep seated, vertical gates, valves , bulk heads etc.

(v) Navigation canals are provided with miter gates to control

In India gates and control equipment are planned and constructed on conventional lines based on Indian standards which are largely drawn on the basis of some prominent foreign guidelines. These codes of practices cover a wide range of topics from selection of gates and their hoists to the maintenance considerations. There are specific and well defined guidelines for every aspect of gates including their geometry, metal works fabrication details and so on. Planners in India normally adhere to these standards. Provision of gates and their operating equipment is generally dictated by the civil structure layout. The optimisation applied by the civil designers prevails on the planning of gates and hydro-mechanical equipment layout. Width and height of gate bays based on the hydraulic considerations and on the practical aspects of gate fabrication, erection and handling are also considered.

While standards stated above were applicable to the types of dams and structures being built during pre-sixties or seventies and they served that purpose well then, but the new sites being explored in India and elsewhere now pose totally different site conditions and challenges. For example, in Himalayan regions, we have to manage sediments which are in much higher quantity and of different distribution pattern than that observed in the peninsular region. There is a new requirement from environmentalists to let minimum flow in the downstream of the projects. A new range of products and advancements in construction and fabrication technologies are now available. This includes high capacity and software controlled hydraulic operators, SCADA systems for remote operation. Cavitation and abrasion resistant steels, self lubricated maintenance free bearings are also now easily available. High load carrying and reliable pre-stressed concrete technology has made inroads in the modern construction in India. Other civil engineering sectors in India have already adopted these advances for performance improvement and economy as well as sustainability. Gates and their operating equipment are now required to be planned and provided to address new issues and increasingly adopt these modern techniques. Standards and guidelines in respect of gates and hoists need considerable updating.

A project may have no gated controls at all on one hand and may have different types of gates operated by a variety of mechanisms on the other. But wherever gates are required to be provided, they should be incorporated such that they their performance is reliable and satisfactory. There is little use of a gate which either is not able to hold the water behind it or is not operable due to mal functioning operating equipment. Similarly, gates provided for intended operation of silt exclusion are not put to operation during the useful project life and later on are forgotten thus defeating the very purpose of their provision and ultimately compromising the project performance. Some gates are not operable due to wrong choice of the operating equipment while planning and malfunctioning of the operating equipment. In order to derive optimum and efficient performance through the water resources development projects, it is essential to dovetail functioning of the equipment with the pattern of operation of the project(s) through its working life as well as during the construction of projects. It also needs to be recognised that it is not only sufficient to provide gates and their operating equipment in a particular project but it is equally important to foresee their suitability and performance in long run resulting in a better and efficient water management system.

3. SOME CASES OF MISHAPS IN INDIAN PROJECTS

Some undesirable incidents in India attributable to poor management of projects and inadequacies in the design are reported below. It may be noted through these cases that mostly gate controls are distressed, failed or mal functioned but the overlying civil structure housing these gates is remained intact. These incidents illustrate that gates and their controls are required to be dealt more seriously in respect of durability, sustainability and efficient operation through planning to implementation. Probably some risk mitigation measure to result in a “fail safe” operation should have been incorporated in these equipment and their planning, which are indicated in the last column to prevent such recurrence.

Table:1 Some cases of mishaps in Indian projects

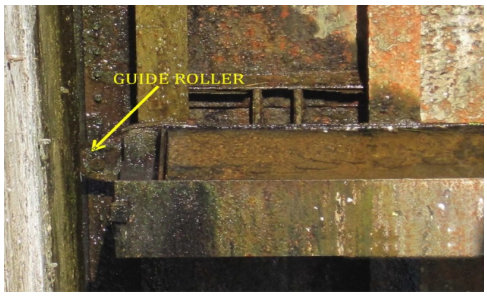
S. No	Project	State	Year of compl-etion of Constr-uction	Type of Gate and equipment related with the incident	Year of distress	Probable reason(s) of incidence of failure/ distress	Negative impact on project performance	Missing Risk Mitigation Measure
1	Srisailam Dam & HEP	A.P.	1986	Radial Gates on dam crest	2009	Gates subjected to higher pool conservation level than design.	Power house area flooded resulting in loss of generation.	Quick response feature in gate operation and margin for extra flood lift
2	Wazirabad Barrage	Delhi	1959	Barrage Crest gates	1991	Gates subjected to high flood un-warned	Water supply of Indian capital threatened	Reserve for extra load due to high flood.
3	Nathpa Jhakri HEP	H.P.	2004	Draft tube gates for turbine.	2005	Turbine flooding and non-closure of draft tube bulk heads coinciding with burst of labyrinth pipe in PH.	Power generation affected	Full closure of DT under all risk levels
4	A Barrage on international boundary		1975	Barrage under sluice gate and spillway gate	1996 to 2011	Structural failure due to loss of metal	Uncontrolled water flow across international boundary impacting domestic interests	Maintenance free gate components.
5	Singur Dam	A.P.	1990	Dam crest gates	1990	Defective fabrication of gates	Drinking water to twin cities of Hyderabad and Secunderabad affected	Accessibility of load bearing components.
6	Koteshwar H.E.P	Uttarakh -and	2011	Dam gates and intake gates	2010	Unpredicted flood	Flooding of project area resulting in project delay	Sequencing of erection of gates.
7	Kalubhar project	Gujarat	1986	Dam gates	2007	Gates subjected to high flood	Loss of storage affecting crop water requirement	Reserve in load bearing components.
8	Chukha H.E.P	Bhutan	1986	Dam gate and Silt flushing tunnel gate	1987 to 91	Non closure of SFT gates and malfunctioning of dam gates	Loss in power generation	Positive gate closure features.
9	Purulia Pumped Storage Scheme	W.B	2008	Depletion sluice gates	2010-11	Malfunctioning of bye-pass	Flooding of gate shaft and loss of generation	Isolation of gates at reservoir pool level for maintenance & inspection
10	Tenu-Bokaro link	Bihar	1969-70	Service and Emergency gate of water supply intake	2002	Gate installation issues	Adversely affecting Bokaro city water supply	Accessibility of gate location and provision of maintenance bulkhead.

These are few representative examples meant to illustrate that though the civil structure has remained by and large safe, but the project performance is severely affected due to the absence of failsafe strategies functioning of the gated controls. Some photographs of recent events are also presented below to drive home above points.

OVERFLOWING SRISAILAM DAM IN OCT -2009

DEVASTATED TOWN DUE TO SRISAILAM FLOODING

A GATE COMPONENT HEAVILY RUSTED



HEAVY RUSTING DUE TO LEAKAGE OF WATER

BROKEN GATE COMPONENTS

4. SHORTCOMINGS OF PRESENT PRACTICES FROM PLANNING TO IMPLEMENTATION REGARDING GATED CONTROLS

After review of different case studies referred and dealt in CWC, following issues emerge:

- A conventional and at times rudimentary approach is adopted for choice of type of gates
- Total cost of controls being much less in comparison to overall cost, much attention not paid for providing a good control equipment
- Misplaced idea of economical layouts and gate weight optimisation are pursued
- Gate operating equipment not suiting remote location
- Material specifications not suitable with site conditions, e.g. water quality and sediment effect is quite often unaccounted
- Material specifications ignore maintenance culture
- Faulty and inadequate specifications of materials and fabrication
- Lope sided supervision often from personnel not conversant with procedures of fabrication and erection
- Absence of modern fabrication practices
- Shying away from numerical and physical model studies to predict performance during operation
- Limitation of vendor capacity regarding time schedule of completion of project and long term performance guarantee
- Criteria to award work being flawed resulting in in- experienced and unskilled vendors
- Absence of competition among capable vendors and suppliers

A careful study of above points calls for the need to inculcate a fresh culture of procedures and practices for overall optimum and efficient performance of water resources projects through properly planned and installed gates and their operating equipment. Some desirable changes in our practices are suggested as under:

- Plan and provide maintenance gates invariably. There is a tendency to rely on the water levels to fall low and facilitate maintenance in dry conditions. This may no longer be the case due to the changes in the hydrological conditions.
- Carefully envisage regulating requirements of any installation duly appreciating the fact that a regulating and non-regulating gate differ in character and hydraulic behaviour significantly.
- Provide only appropriate types of operating arrangements which are simple and easy to handle in long term. Regard to ingenious technology may also be kept in mind.
- Desist from providing sophisticated arrangements at remote locations due to maintenance considerations.
- Provide flushing outlets adequately.
- Consider appropriate types of outlet gates for environmental flows seriously.
- In dams low level operating sluices and gates are essential. They serve an important function of regulating the controlled filling of dam and depletion needs.
- Include maintenance free practices.

5. ROLE OF VENDORS

Gated controls being custom made to suit the specific project applications and also involving practices and procedures of heavy metal industry are relied upon vendors to a great extent. In early days, gate suppliers and vendors were required to supply fabricated gates and their hoists and other operating equipment based on the drawings supplied by the department or the “client”. However, this practice could not be continued due to variety of reasons. These days gate manufacturer makes fabrication drawings at his end and gets them approved before fabrication. A good vendor may have services of professionals to do this work at his end but some agencies not experienced in this work may land up

in doing an inferior job and may miss many important details in the working drawings. Malfunctioning gate and its operating equipment resulting in inefficient operation will be imminent in such cases.

Some vendors do not have financial standing to afford to have workshops and in house capacity to do heavy engineering jobs and quality control at their works thus relying on sub-contracting many items and eventually compromising the quality and performance. They also cannot hire services of capable and qualified engineers. At times, gate and hoist manufacture and erection is left to some illiterate personnel having no professional background, howsoever impressive is the list of experts shown at the time of award of works to such vendors.

It is necessary that vendor capability is matched and commensurate with the job requirements for the delivery of equipment of water resources projects which result in an efficient water control arrangement. Profit motives of such equipment suppliers should not compromise with long and efficient water management through our projects. Water is a very important and increasingly getting scarce resource and we owe to supply it to various stake holders in a most efficient and equitable manner. A flawed and narrow outlook of vendor allotment cannot be allowed to prevail over the larger interest of our priorities.

6. CONCLUDING REMARKS

Sustainability of water resource development and efficient and equitable delivery of water to all user groups through projects planned and constructed in efficient manner depends to a good extent on the gated controls and hydro-mechanical equipment provided therein. There is an urgent need to have a relook towards practices from conceptualisation to commissioning and from commissioning to maintenance in a professional and contemporary manner. Outdated practices without concern for immediate environmental needs are required to be done away with and should be replaced with sound criteria resulting in long lasting and rugged equipment to match the robustness of civil structures of water resource development projects.

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