# RESERVOIR SAFETY

by

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In all engineering designs a certain amount of calculated risk is taken. The higher the risk in the design, the lower the cost of implementing the project, but the likely lifespan of the project is reduced. The design risk taken is mostly dependent on the extent of damage to life and property in the case of project failure. Thus where there is greater likelihood of danger to life the lesser the risk taken in design.

When Reservoirs are designed, certain parameters such as the size of the spillway, the flood lift or afflux, the freeboard, etc. are allowed for by designing against a return period of 50 or 100 years in the case of small reservoirs with few or no people living below the reservoir. For large reservoirs with many villages below the dam, the design return period may be 1,000 or 10,000 years or higher.

The earth embankment designs and concrete and other structural component designs incorporate the required factor of safety as normally practiced for such designs.

Under normal circumstances, the reservoir reaches critical conditions of designs when it is full and a storm equal to or greater than the design storm strikes the catchment. This severe weather condition itself forms a fair warning to the people to be alert and the reservoir condition is frequently monitored during such storm period enabling fair disaster warning to be issued with sufficient notice to assure at least the safety of life.

On the 20th of April this year we experienced in our country for the first time in living memory the case of a reservoir breaching during a spell of dry period on a fair clear night bringing tragedy and disaster with hardly any warning. Nearly a hundred people lost their lives, thousands lost their homes and properties, twenty thousand acres of irrigated land got damaged by the ensuing floodwave. The cost of repairs is estimated to be above Rs.250 millions!

One is left with the uneasy feeling that something is amiss. Yes, a little warning, even if only a few more minutes for the poor brothers and sisters to be sufficiently awake to realise the danger and flee to safety so that more lives could have been saved from an untimely end. Even if there was nothing we could have done, at least we should do in the future, the very near future, something to ensure a warning to alert people ahead of possible disasters of this nature.

Let us analyse what forms of failure can arise to reservoirs and how we can in the first instance avoid a dam breaching, and in the second instance device warning systems to give maximum notice of impen-

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ding disaster so that people may get to safety in time, may be saving some valuables also.

To avoid a dam breaching there are many functions the Irrigation Staff performs during stormy weather and as routine inspection and maintenance.

**During Stormy Weather:**

In reservoirs incorporating gated spillways it is necessary to open the spillway gates when the water rises above Full Supply Level. In some cases it is necessary to open the gates and lower the level of the reservoir when it is known that the catchment has experienced high rainfall. This requires efficient communication systems working reliably during stormy weather.

The operation of the gates at present is mainly manual and requires human intervention. It is known that the flood inflow can be very rapid in the form of flash floods and it is absolutely essential for the operation of the gates be done on time. The warning (notice) may be only a few hours and there have been cases of reservoirs and anicut failure due to non-operation of the gates on time. The operation may not be possible in the bad weather and lighting, tne operator may be sleeping comfortably through the rain which may be away in the upper catchment, or the operator may not be at site.

Hence now we do not in general incorporate gates in small reservoir spills. Where gates are absolutely necessary, we insist that the gates be designed for automatic opening. It is worth noting that in the case of massive Victoria Dam automatic gates are incorporated.

Where manually operating gates are installed, as a first step, it is a good idea to install warning sirens etc. to warn the operator and other staff to take action on operating the gates. As a second step we could automate the opening of the Gates using the methods open to us using modern technologies. I shall go into further details under the section on "Disaster Warning Systems - A proposal".

**Normal Maintenance Inspection**

At present the normal inspections carried out on earth bunds are mainly limited to checking of seepage, noticing subsidences, sink holes, runnels, anthills and damage by animals such as wild boar and crocodiles.

On concrete, steel and stone masonry structures the inspections are mostly visual; what can be seen from the outside and interpreting reports by labourers or villagers who can creep into small sluices. The structural failure of sluice barrels and other stone or concrete structures can be quite sudden. Inspection of the inside of sluice barrels are very difficult. Officers experienced in examination of such works may not be agile enough to creep through small barrels.

Here again I feel modern technologies can give a solution which I shall detail out under the next section.

**Disaster Warning Systems - A proposal**

Where manually operated gates are installed, it is a good idea to install warning sirens etc. to warn the operators and other staff to take action on operating the gates. Also warning devices sensitive to the water level and/or rate of change of level in the river can give audible warnings for people near the river to get to safety on time. Electronic devices using power from a car battery to sound a siren can easily be designed and constructed using locally available components and skill for less than Rs.3,000/-. A solar panel can be added to recharge the battery at an additional cost of Rs.2,000/-.

Such devices will ensure that warnings are given when gates have to be opened and when sudden river level rises occur.

As a further step it is possible to look into the feasibility of automating the operation of the gates using Modern tech-

nologies and locally available skills and components and materials. This should relieve the staff engaged on flood work, some measure of relief in tension though not the degree of responsibility.

Modern equipment such as Closed Circuit T.V. for use underwater with proper lighting and monitoring equipment may be very useful for inspections of sluice barrels and other confined spaces. There may be many sluices with high cavitation damages, corroded reinforcement etc. which are unable to inspect at present.

Voids and Cavities behind concrete sections such as sluice barrels will eventually lead to structural failure. But detecting such cavities are not possible. Are there any Ultra sonic or similar equipment which can help in this? We would like to know from an august audience like you who are knowledgeable in modern technologies.

But are there any modern equipment which can detect an earthern bund or concrete structure in distress and nearing collapse? We would like to know. If such equipments are available we may be able to avert future disasters and also in unavoidable disasters we can minimize loss to life and property.

The present visual monitoring of the seepage flow can be automated using electronics and sensing probes located in the seepage drains. Any sudden changes in the volume of seepage can be made to trigger a warning alarm whatever the time of day or night to warn the staff the impending danger so that necessary action can be started on time.

Similarly water level or rate of change of water level sensors below the sluice can warn of sudden increase in discharges so that remedial action to solve the problem can be taken or in the event no immediate remedy is possible, people can be altered well before a serious breach or damage occurs and minimise the loss of life and property.

I place before you my thinking which does not necessarily reflect the thinking of the Irrigation Department at present. I feel that Modern Technologies have to be applied in our projects to enhance the safety and working of our projects.

Thank you very much for your patient hearing.

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