PREPAREDNESS OF DAM OWNERS FOR IMPLEMENTATION OF DAM SAFETY ACT

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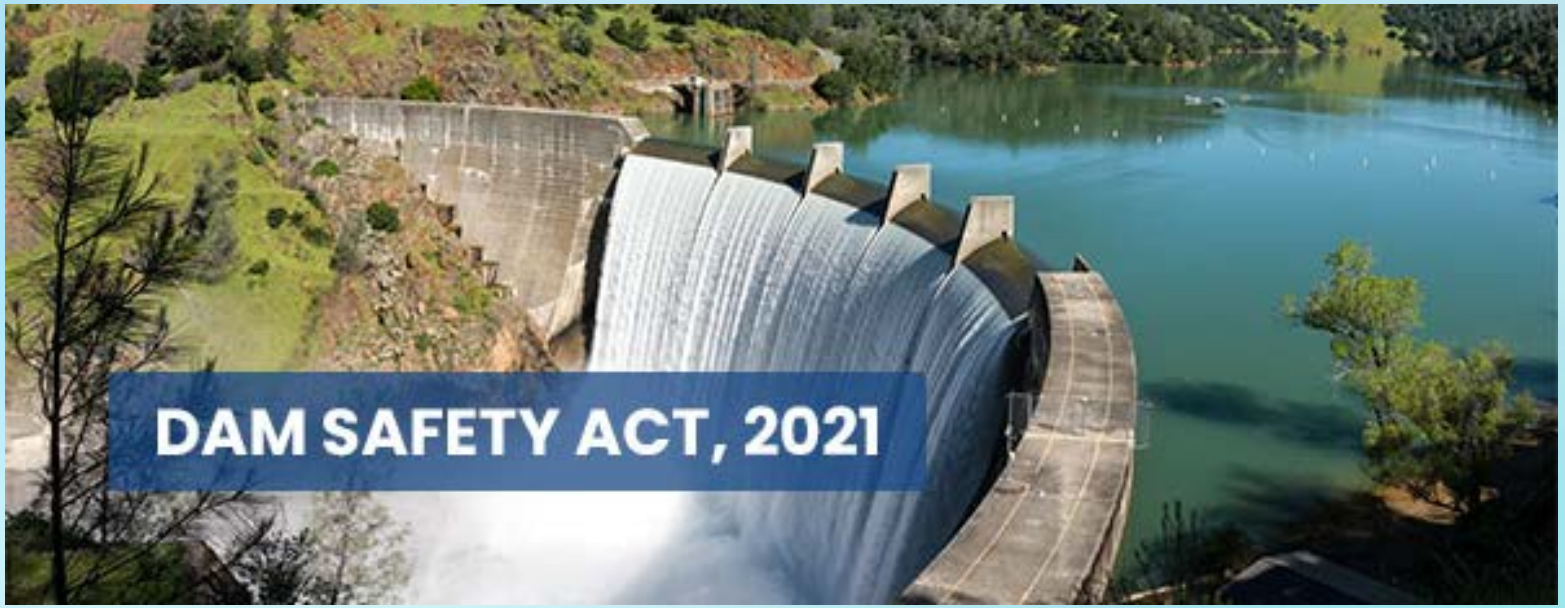
Why Dam Safety?

- Dams are very costly infrastructure built at great expense and effort and are a public asset.
- Dams enable management of an ever lasting water resource and are required to last forever.
- With the change in environment, age and usage pattern, the continued operation of a dam requires systematic review and upgradation at regular intervals
- Dam safety is an asset management discipline relying on science and technology and has components of public administration
- Dams do pose hazard if not maintained or managed properly. Management of risk is also covered by the dam safety discipline
- Being linked to public safety and benefit assurance, Governance structures are needed to implement and supervise the activities under the dam safety

Dam Safety across the World

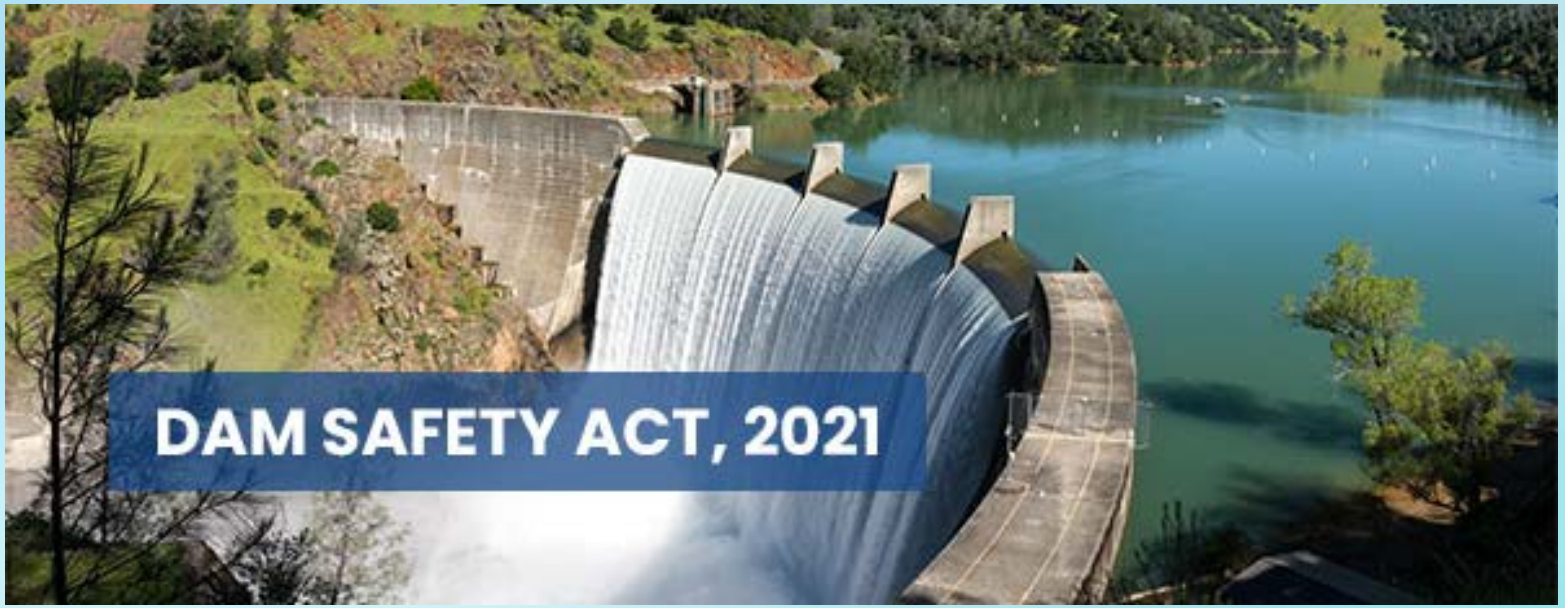
- Most of the economically developed countries have dam safety assurance systems in place through enactments.
- UK- Earliest act in 1930, revised in 1975
- Finland Act in 1984, revised in 2009
- France Largely renewed in 2007
- Italy Original legislation 1933, latest revision 2007
- Norway Act in 1981, revised 2010
- Portugal Enacted 1968, latest revision 2007
- Spain 1967, 1994,1996, latest 2007
- USA National Dam Inspection Act 1972, National Dam Safety Program Act 1996
- Australia ANCOLD guidelines (2003) used as basis by all the states for individual dam safety legislations

Dam Safety Activities in India



- 1975- State Irrigation Ministers urge Central Government to establish dam safety services
- 1979- Dam safety Organisation created in Central Water Commission
- 1982- A standing committee on dam safety is constituted and provides an assessment of dam safety practices in India (1986)
- 1987- National Committee on Dam Safety established (reconstituted from time to time)
- 1987-1989 UNDP assistance programme on design, dam safety and instrumentation is taken up jointly between CWC and states
- 1991-1999 World Bank assisted Dam Safety Assurance and Rehabilitation Project taken up participated by CWC and Odisha, MP, Rajasthan and TamilNadu
- 1987-2010 Formulation of Dam Safety legislation taken up at central level and examined with the states incorporating their suggestions and views
- 2010- Dam Safety act first version tabled in Lok Sabha and discussed
- 2017- Modified Dam Safety legislation tabled in Lok Sabha and enacted in 2021
- 2010- till date- Dam Rehabilitation and Improvement Project taken up with states phase I, II

1. Dam Safety Act 2021 –Administrative And Technical Processes And Workflows



- An Act to provide for surveillance, inspection, operation and maintenance of the specified dam for prevention of dam failure related disasters and to provide for institutional mechanism to ensure their safe functioning and for matters connected therewith or incidental thereto
- Union should take under its control the regulation of uniform dam safety procedure for specified dam to the extent hereinafter provided.
- Two tier structure- consultative and implementation at Union and State levels
- Statutory establishment of National Committee on Dam Safety Consultative mechanism for all the major owners of dams and other expert organizations, providing guidance for working of other mechanisms for implementation of dam safety activities
- Establishment of National Dam Safety Authority and extension of its jurisdiction over the whole of India Looking after the implementation of the act, act as a regulatory and quality assurance agency for capacities and competencies, direction to the dam safety programmes at various units

2. Responsibility Levels For Dam Safety Assurance (Union, State, Dam Owner) As Per The Act - Multiple Roles Play by Various Governmental Agencies

- **Prime responsibility has been fixed on the owner of the dam for implementing required procedures and practices, mobilising required resources and providing for the continued surveillance**
- **State(s) have been entrusted with the supervision and enforcement functions for implementing the provisions of the act. Support in form of a state level dam safety committee provided**
- **States and Union having powers to take punitive action on consistent failures on part of the dam owner**
- **National level implementation of the act being responsibility of the National Dam Safety Authority**

3. Focus on surveillance and rehabilitation- rehabilitation to remain in focus for quite some time

- ✓ **Prime focus of the act is on establishment of surveillance processes and follow up action then on.**
- ✓ **Various types of inspections are required to be carried out at different levels of details and expertise**
- ✓ **We have more than 5200 large dams and innumerable other small dams with substantial number having nearly 50 years or older thereby needing detailed attention and rehabilitation will remain focus for quite some time.**
- ✓ **For covering such a large number of dams, the requirements of a pool of capable engineers is also equally large.**
- ✓ **Development of standard procedures for various structures and components becomes a requirement for bringing the inspections on a common technical and managerial base line.**
- ✓ **Natural sciences like hydrology, seismology and materials being under continued development and new insights, the repetition of the evaluation exercises make the entire programme perpetual**
- ✓ **Revisions in the operating protocols also provide additional requirements for ensuring safety during the new operational regime**

4. Iterative nature of Dam rehabilitation process and optimization of investments

- **The process is multi-disciplinary with a range of expertise ranging from hydro-meteorology, seismology, hydraulics, material sciences, simulation and mathematical modelling and risk quantification, construction planning and financial planning are involved in definition and implementation of rehabilitation process**
- **The final rehabilitation measures emerge after interaction of the various outputs and inter-dependencies must be understood by the involved personnel.**
- **Considerable preparation is required for formulation of a rehabilitation programme for large dams. Part rehabilitation measures without overall plan may lead to a false sense of security.**

5. Special character of rehabilitation process vis-à-vis new construction

- **Very frequently, the operational constraints like minimum water levels allowed, requirements of the beneficiaries and continuance of the operations make the evolution of the solution challenging in terms of technical and financial approaches to be adopted.**
- **Materials and techniques required to be used are quite frequently unusual and also proprietary posing challenges in tendering and awarding the works**
- **Simulation processes involved may not be adequately covered by the design standards thereby posing challenges on judgement and rehabilitation course to be adopted**
- **The outputs of the rehabilitation activity are the continuance of the operation and little or no creation of additional tangible resources. This makes the task of getting funds allocated for the purpose a difficult challenge in an environment where the competition with the additional asset's creation.**

6. Institutional framework required for dam safety assurance at various levels

- Dam safety being a continuing activity, strong institutions are required for the success of the programme.
- Act deliberates extensively on the institutions required and assignment of duties and responsibilities.
- Institutions can be generated with external funding, but their continuation is a requirement that is often over looked by various players.
- Institutions are required to be repository of knowledge pertaining to dam safety and continuation of expertise is a must.

7. Owner level framework

- Detailed stipulations are laid down in chapter VII of the act.
- A specifically charged unit at appropriate level is essentially required.
- Unit is primarily responsible for carrying out the routine inspections and man the key positions in times of emergency and facilitate integration of the dam and reservoir into a disaster management framework of the institution
- Ensure minimum functional instrumentation including structural and hydro-meteorological set ups, observations and interpretation of the readings and their dissemination to related parties
- Raise needs for obtaining expert advice as needed
- Analyze and quantify the risk to the dam
- Report and liaise with the state and central level authorities in respect the specific dam and provide necessary periodic inputs as specified by the act and required from technical and administrative angle

8. State level framework

- Maintain liaison with all the dams located in its jurisdiction and keep a regularly updated database of their health and safety status by maintaining perpetual surveillance, inspections and monitoring O&M
- Allocate necessary technical and administrative staff and officers with required knowledge and skills
- Implement inspection programme with due expert inputs on a third party basis for a neutral assessment of safety status and suggest remedial measures
- Ensure implementation of dam safety act by the dam owners
- Commence its involvement as a reviewer right from planning and design stage for ensuring a resultant safe dam.

9. Central level framework

- **Similar functions as state level committee and authority but enhanced to work with the state level framework**
- **Develop and disseminate standards and guidelines for ensuring technically competent procedures and solutions for ensuring the dam safety across the country**
- **Dispute resolutions between state level authorities in relation to dam safety with final say in the matter**

10. Capacity requirements at various levels, personnel and also knowledge capacities

- As demonstrated above, very special requirements exist at different levels.
- Capacities are required in the fields of Hydrology, engineering seismology, concrete technology, geotechnical engineering, numerical modelling for structural, hydrodynamics and hydrological simulations, hydro-mechanical structures and construction techniques
- It is difficult to maintain in-house expertise to carry out all the works in the disciplines given above. However, the awareness of the fields and capability to guide the processes and appreciate inputs from various third-party expert agencies is a must.
- Nurture the development of expertise in various fields and provide support for associated research and development institutions to create nodes of excellence in respective disciplines
- Coordinate and manage extensive programmes specified in the act for dam safety assurance

11. Role of experienced professionals

- ✓ **Dam reveals various kinds of distress and safety shortfalls as symptoms exhibited on its body and on components. Interpretation of these symptoms require long exposure to the fields as mentioned above.**
- ✓ **Not all dam engineers have a wide exposure as to cover the entire gamut of fields and hence discipline experts are essentially required to guide the dam safety assurance process**
- ✓ **With a large body of dams coming up for review, the involvement of Dam Safety Review Panels meeting the requirements of disciplines involved is a must.**
- ✓ **Involvement of DSRP should be at various stages of safety assurance and rehabilitation plan. Commencing from problem definition (requirement specification), rationalizing outcome of investigations and review of measures proposed as remedial works**
- ✓ **Experienced professionals should be provided with adequate information about the dam and distresses for generating a comprehensive response.**
- ✓ **Comprehensive reviews should be carried out using such expert professionals only.**
- ✓ **Involvement of external members should be encouraged to generate an un-biased and dispassionate view of the matters.**

12. Role of specialised organisations and entities

- **Dam safety requires deployment of special tools and procedures which may not be commonly required in a fresh dam design**
- **Such requirements need deeper understanding of the underlying phenomena and correlation of the observed phenomena to the causative mechanisms through laboratory or theoretical means.**
- **Special skills and equipment are required for in-situ or laboratory investigations on the dams**
- **Such measures are required on a infrequent basis as there is no uniformity of the problems in different dams. Hence, it becomes difficult to make investments solely for a single dam where the use may be a one-off exercise**
- **However, at a national level, such demands exist and can sustain an identified group of organisations/ entities who can provide such services.**
- **Keeping the magnitude of developments in dam safety in view, a set of institutions spread across various parts of the country are required and strengthened**
- **Specific areas needing strengthening are quite extensive precluding their enumeration here.**

13. Development of guidelines and manuals at various levels- technology level, higher management level, specific dam level

- Such documentation reveals the collective thinking and best practices of the professionals and is very valuable in standardization and knowledge dissemination.
- Good number of manuals and guidelines have been brought out through DRIP 1 programme and more are being brought out under the continuing programme.
  The publications cover inspection protocols and reporting, instrumentation, risk analysis, rehabilitation technologies, preparation of Emergency action plans etc. Can be downloaded from
  https://damsafety.in/index.php?lang=&page=Downloads&origin=front-end&tp=1&rn=1
- The guidelines being general in nature, require tailoring and modifications to suit the site conditions. Such effort has to be taken up at the state level.
- Additional guidelines are required to be taken up especially in the areas of seismic analysis and numerical modelling of dams, quality assurance, construction planning, underwater inspections, use of drones for surveillance and reporting etc.
- There are other international guidelines are available from ICOLD, FERC, FEMA, USBR, US Army Corps of Engineers etc.

14. Continuation of knowledge and information transfer

- Dams have a practically indefinite lifetime. The personnel in charge of dam operation and maintenance continue to change with time. Maintaining continuity of the basic information is obligatory.
- Extreme events like PMF or SEE may or may occur at any time and the personnel should be aware of the protocols to be followed in such events. However, the tenure or seniority of the person available at the site may keep on varying.
- Standard Operating Procedures and their documentation is a pre-requisite for capacity building of the available personnel.
- Basic documentation and information about the dam like design provisions drawings and as built information is required to be preserved and passed on for future reference.
- Setting up of Mock exercises for familiarizing the new personnel with the SoPs is a required measure. Multimedia based real time simulations to be developed for major dams having significant disaster potential.
- All operational history of major components like hydro mechanical components and other remedial measures need be maintained for future reference

15. Needs for generating awareness in associated governance spheres

- Dam safety assurance require multiple permissions and finances. Often, these are controlled by setups who will not have first hand feeling about the issues being highlighted. Explaining implications becomes a first step towards the release of resources.
- Requirements of safe operations of dams often conflict with the perceptions about the immediate inconvenience to the affected populations downstream. The other administrators and influencers have to be made familiar about the protocols and implications of violating them for short term reliefs.

16. Implementation of rehabilitation measures

- ✓ **Capacity of the personnel at site needs upgradation as new methods and techniques are often employed.**
- ✓ **Timelines involved are often tight and work has to be completed in the slots available coordination amongst agencies needs stronger site support.**
- ✓ **Some of the remedial measures have real time operation implications like pre-depletion etc. Implementation of such measures require setting up of decision support networks and allocation of responsibilities.**
- ✓ **Documentation of the works being performed, and benefits being achieved needs careful and systematic preservation as they may be required in future for next set of remedial measures.**

17. Role of continual upgradation of knowledge and products

- The field of development of artificial materials is dynamic and continually evolving.
- Materials and techniques being employed often have origin in associated disciplines. The performance will have to be evaluated in respect of the dam environment. Knowledge about the underlying principles becomes necessary at project management level.
- Knowledge upgradation is necessary throughout the hierarchy of safety managers and designers so that the planning process remain updated for new concepts and ideas.
- Role of academic and research institutions become crucial in implementing continuing education and training exercises.

18. Integrating associated agencies and institutions for implementing the dam safety assurance processes

- Dam safety assurance requires continual involvement of the expert institutions and field personnel.
- Process being iterative, the results of one exercise may throw up needs for additional exercises or change of further course of action requiring continued involvement of other agencies.
- Often the expert agencies do not have full appreciation of the problem. In such event, close interaction at intermediate level helps rather than waiting for the final output and finding inconsistencies

19. Real time data acquisition and analysis for early warning and actions

Dam safety act recommends that:

- **32. (1) Every owner of a specified dam shall have a minimum number of such instrumentations at each specified dam, and installed in such manner as may be specified by the regulations for monitoring the performance of such dam.**
- **(2) Every owner of the specified dam shall maintain a record of readings of the instrumentations referred to in sub-section (1) and forward the analysis of such readings to the State Dam Safety Organisation, in the form, manner and at such interval as may be specified by the regulations.**

Continued....

- **33. (1)** Every owner of a specified dam shall establish a hydro-meteorological station in the vicinity of each specified dam capable of recording such data as may be specified by the regulations.
- **(2) Every owner of the specified dam shall collect, compile, process and store data referred to in sub-section (1) at a suitable location.**
- A minimum instrumentation and observation programme is necessary for all dams for assessing their health from time to time.
- **In case of earth/ rockfill dams, seepage measurement, surface settlements and regular monitoring of its section is a minimum necessity.**
- In case of Concrete/ masonry dams, the seepage measurement, uplift measurement, visual inspections for deleterious effects are a minimum necessity. For large dams, the deformation measurements through plumb lines or precision surveying methods is also recommended.
- **In all cases, hydro-meteorological monitoring in the catchment and on the dam is a strong requirement for safe flood operations of the dam.**

Summing Up

- **Institutions will play a key role in implementation of Dam Safety Act 2021**
- **Implementation of the act provisions require a multitude of disciplines and skills**
- **In order to assume the designated role, each of the institution at every level will have to generate and maintain special skill sets.**
- **Role of competent expert institutions and individuals is key to the dam safety assurance**
- **Dam safety assurance regime will require capacity development in the new areas and spread of new knowledge amongst the practitioners**
- **Dam safety should not be considered a one time exercise and perpetual surveillance is the key for which all the institutions will have to play their own roles well.**
- **Lot of works and efforts await us for making this happen.**

- Apart from the Managerial and governance areas discussed in this presentation, there are a large number of technical aspects pertaining to dam safety.
- Paucity of time constrains their discussion at a venue of this nature.
- More interested audience is recommended to take an online ICID-Aqua foundation course on dams and network safety
- Visit www.Damsafety.co for more details

THANK YOU

Institutional Strengthening of Dam Safety Organisations; Training & Capacity Building of Personnel at all Levels; documents for Dam Safety; Review of Dam Instrumen-tation; Adoption of Guidelines and Manuals Issued by Central Organisation; Preparation of SOPs; Preparation of Comprehensive Dam Safety Evaluation etc.