

Short Course on **RESERVOIRS AND SEISMICITY**

25 October 2019

Conference Hall of CBIP, New Delhi



Organised by



Indian Committee
on Large Dams



Central Board of
Irrigation & Power
New Delhi



Central Water
Commission

under the aegis of



International Commission
on Large Dams (ICOLD)

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OUTLINE OF SHORT COURSE

The Short Course gives an overview on the possible effects of reservoir-triggered seismicity (RTS) on the safety of large dam projects. The first case of RTS was observed in connection with the impounding of Lake Mead, the reservoir stored behind Hoover dam in USA, in 1935. Since then, over 100 cases of RTS have been reported from all over the world. In the past, the term “induced seismicity” was used to describe these seismic phenomena, but as the seismicity is usually associated with tectonic processes, the correct term used in connection with large dams and reservoirs is “reservoir-triggered seismicity”. This is very important as dams and reservoirs cannot create earthquakes. The term induced seismicity would only be appropriate with, for example, the collapse of underground cavities formed by people (mining activities), hydraulic fracturing and others, which, in general, is less important for dams than RTS.

Hundreds of papers have been written on RTS and many more will be published in future as dam construction is going on in the foreseeable future. Because the largest RTS events cannot be predicted, which is a hard problem, similar to earthquake prediction, RTS has become the preferred dam safety topic for people opposing large dam projects. As dam engineers and owners were often not familiar with RTS, in the past, it was addressed by introducing a separate load case for dam design, which was called “induced seismicity”. This term is still used in some projects or old guidelines, but as mentioned above, this is an incorrect term. Sometimes it takes a long time until terms and methods, which are obsolete, are replaced.

The state of knowledge on RTS phenomena, including the physical processes causing RTS and several case studies, is discussed in ICOLD Bulletin 137. In the present short Course a rational assessment of RTS from the viewpoint of dam engineers is given. RTS is an old phenomenon. However, interest in induced seismicity caused by fracking and liquid waste storage in the US as well as geothermal projects, has grown significantly in recent years. The underlying processes of these types of seismicity, i.e. cracking due to increase in pore pressure, are similar to that of RTS. However, the pore pressures applied in these projects are several orders of magnitude higher than those caused by the filling of a reservoir.

Strong earthquakes, which are suspected of being reservoir-triggered, have occurred in the reservoirs formed by the Koyna gravity dam (India), Hsinfengkiang buttress dam (China), Kremasta embankment dam (Greece), and Kariba arch dam (Zambia), so that the general interest for this phenomenon has sharply increased. The maximum magnitudes of the seismic events observed in these reservoirs were in the range of 6.0 to 6.3. As reservoir-triggered earthquakes tend to have shallow focus, the ground motion at the dam sites of Koyna (1967) and Hsinfengkiang dams (1962) was very severe and caused cracks in both dams. These two approximately 100 m high concrete dams were subsequently repaired and strengthened

and are in operation today. The microseismic activity in the reservoir region of Koyna and Hsinfengkiang dams is still high. For example, in the Koyna dam region nearly 100 earthquakes with magnitude $M > 4$ and about 10 events with $M > 5$ have occurred since 1967. The ground motions caused by these earthquakes are of no serious concern for the safety of the strengthened dam.

RTS was mainly observed at large storage dams with maximum reservoir depth exceeding approximately 100 m and reservoirs with a volume of over 500 Mm³, which tended to decrease with time after the first filling of the reservoir.

In order to assess the implications of RTS on the safety of large storage dam projects, it is necessary to have a proper understanding of the current seismic design criteria. Unfortunately very few who question the safety of large storage dams under the effect of RTS know about it and therefore unrealistic scenarios, questioning the safety of dams, are brought forward.

The seismic design criteria and methods of dynamic analysis of dams have undergone substantial changes since the 1930s when earthquake actions have been introduced to the design of dams. Today we have a clear concept for the seismic design criteria to be applied when a dam is subjected to ground shaking and methods of dynamic analysis have been developed, which allow the calculation of the inelastic seismic response of embankment and concrete dams.

However, we must recognize that earthquakes can cause multiple hazards in large dam projects including ground shaking, fault movements in the footprint of dams and in reservoirs, rockfalls, landslides, liquefaction, ground deformations, seepage, impulse waves in reservoirs etc.

The following items are discussed:

1. modern seismic design criteria for dams,
2. possible effects of RTS on dam design,
3. possible effects during the first years of reservoir operation,
4. possible effects on the safety of existing and new buildings and infrastructure in the dam and reservoir region, and
5. possible psychological effects of people living in the region affected by RTS.

This is a more comprehensive view of RTS than the one followed in the past, which focused on dam safety only.

The main ICOLD references are:

Bulletin 112 (1998): Neotectonics and Dams

Bulletin 137 (2011): Reservoirs and Seismicity

Bulletin 148 (2016): Selecting seismic parameters for large dams, and

Keeping in view the importance of the subject, the Indian Committee on Large Dams (INCOLD), Central Board of Irrigation & Power and CWC under the aegis of ICOLD propose to organize one day short course on “Reservoirs and Seismicity” on 25th October 2019 in the Conference

Hall of Central Board of Irrigation and Power, Malcha Marg, Chanakyapuri, New Delhi - 110021. The short course will offer a good scope for interchange of experiences to facilitate

exposure of state of art technology in all aspects of RIS, especially considering participation of eminent dam expert from Switzerland.

PROGRAMME SCHEDULE

25 OCTOBER 2019		
09:00 – 09:30 hrs.	Registration	
09:30 – 10:00 hrs.	Inaugural Session	
10:00 – 11:00 hrs.	Technical Session 1	Introduction to reservoir-triggered seismicity (RTS) (Wieland)
11:30 – 12:30 hrs.	Technical Session 2	ICOLD Bulletin 137: Reservoirs and Seismicity (Wieland)
12:30 – 13:00 hrs.	Technical Session 3	Seismicity of Koyna dam and RTS
13.00 - 13.30 hrs.	Technical Session 4	Seismicity of Tehri dam and RTS
14:00 – 15:30 hrs.	Technical Session 5	The 2008 Wenchuan earthquake and the Zipingpu reservoir (Wieland)
	Technical Session 6	Effects of RTS on dams, infrastructure, buildings, slopes and people (Wieland)
16:00 – 17:00 hrs.	Technical Session 7	What can be done against RTS and microseismic monitoring (Wieland)
17.00 – 17.30 hrs.	Concluding Session	Summary and Recommendations (Wieland)
Morning Tea : 11:00 – 11:30 hrs.		Lunch : 13:30 – 14:00 hrs.
Evening Tea : 15:30 – 16:00 hrs.		

WHO SHOULD ATTEND?

The Course is of interest to Planners, Designers, Scientists, Researchers, Engineers, Geologists, Regulatory Bodies, Government Department, Developers Contractors, Consultants and Students working in hydropower Engineering, Dam Design, Hydropower Development, Environmental Engineering, and Structural Hydraulics.

VENUE

The course will be held in the Conference Hall of Central Board of Irrigation and Power, Malcha Marg, Chanakyapuri, New Delhi - 110021

OFFICIAL LANGUAGE

The official language of the course will be English only.

REGISTRATION FEE

The registration fee for participation in the Course is Rs. 7,500/- plus GST 18% per participant by cash/cheque at par/demand draft drawn in favour of “**Central Board of Irrigation and Power**”, payable at New Delhi. 10% discount in the registration fee will be extended to the members of INCOLD.

The registration fee includes working lunch, tea during the course. Registration fee does not include payment for hotel accommodation or meals except those specifically indicated in the Course Programme. Registration fee once paid will not be refunded.

SPONSORSHIP

Scope exists for organizations to be the Sponsor on lumpsum payment with following benefits:

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COURSE SECRETARIAT

Indian Committee on Large Dams

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CONTACT PERSON

Mr. Sunil Sharma, Chief Manager – Tech., M : 9811299136

NOTES:

1. Participants will have to make their own arrangement for travel, boarding and lodging, etc.
2. Last date for receipt of Registration Form is 10th October 2019. Spot registration facility will also be available, provided prior information is received.

RESOURCE SPEAKER

DR. MARTIN WIELAND



Dr. Martin Wieland has been the Chairman of the Committee on Seismic Aspects of Dam Design of the International Commission on Large Dams (ICOLD) since 1999. He was also the Chairman of the Earthquake Committee of the Swiss Dam Society. He is a senior dam and earthquake expert at Poyry Switzerland Ltd. in Zurich, Switzerland, where he has been involved in the seismic safety evaluation of some of the world's largest dams and other major infrastructure projects.

From 1980 to 1990, he was a faculty member in the Division of Structural Engineering and Construction at the Asian Institute of Technology in Bangkok, Thailand where he offered courses on earthquake engineering and structural dynamics and other subjects.

He obtained his MSc and PhD in civil engineering from the Swiss Federal Institute of Technology (ETH), Zurich, Switzerland in 1971 and 1978, respectively. He was a faculty member of ETH from 1978 to 1980 and was the first earthquake engineer in Switzerland.

He was a member of the Structural Advisory Board for the Panama Canal Authority (ship locks for the new Panama Canal recently completed). He was also a member of the panel of experts for the 230 m high Karun 4 and the 203 m high Dez arch dams in Iran, the 195 m high Sogamoso concrete faced rockfill dam in Colombia, and others. He was also the advisor for the newly established Dam Safety Directorate of the Government of Ethiopia, the country with the largest dams and largest dam construction activities in Africa.

He has received an Honorary Professorship from Hohai University in Nanjing, China in 2002, he is a Visiting Professor at China Three Gorges University in Yichang and a Distinguished Adjunct Professor at the Asian Institute of Technology in Thailand. He has authored 300 technical papers in the fields of dam and earthquake engineering and has worked on dam and other infrastructure projects in 34 countries.

Dr. Martin Wieland

Chairman, ICOLD Committee on Seismic Aspects of Dam Design

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ICOLD

Short Course on RESERVOIRS AND SEISMICITY

25 OCTOBER 2019, CBIP CONFERENCE HALL AT NEW DELHI



REGISTRATION FORM

(To be filled in block letters, preferably typed)

- Name of Participant _____
(Surname) (First Name) (Prefix Prof/Dr./Mr./Mrs./Ms.)
- Designation : _____
- Name of Organization: _____
- Mailing Address : _____
City _____ State _____
Country _____ PIN _____
Phone : _____ Fax _____
E-mail : _____
- Payment details
Bank Draft/cheque No. _____ dated _____ INR _____ drawn on Bank _____
is enclosed/is being sent separately.

I intend to participate in the deliberations of the course.

Place _____

Signature _____

Dated _____