National Committee on Seismic Design Parameters (NCSDP) for River Valley Projects

MINUTES
OF
25th MEETING
(28th June & 8th July, 2013)

Secretariat

Foundation Engineering & Special Analysis (FE&SA) Directorate
Central Water Commission
New Delhi

MINUTES OF THE 25TH MEETING OF NATIONAL COMMITTEE ON SEISMIC DESIGN PARAMETERS (NCSDP) FOR RIVER VALLEY PROJECTS HELD ON 28TH JUNE AND 8TH JULY, 2013 IN CWC, NEW DELHI

GENERAL

The 25th meeting of the National Committee on Seismic Design Parameters (NCSDP) for River Valley Projects was held on two days, 28th June 2013 and 8th July 2013, at Central Water Commission, New Delhi under the chairmanship of Sh. A.B. Pandya, Member (D&R), CWC. The list of Members, project representatives and invitees who attended the meeting is given *at* ***Annexure I***.

Meeting commenced with Chairman, NCSDP welcoming the participants and invitees of the meeting. Highlighting the importance of the NCSDP, especially in dealing with the policy related issues of dam safety, chairman stressed the need to resolve some of the issues that have emerged after the application of new guidelines.

Commenting on the observed trends of PGA and seismic co-efficient values in the recently submitted studies, Sh. S.K. Sibal, Director, CWC said that the PGA values indicated in the study reports seems to be on the higher side. He also stated that mention of the PGA values in the Minutes of the Meeting leads to some confusion, even though it is not being used directly as a design input. He was of the view that approved design spectra should be incorporated in the Minutes in place of PGA values. Agreeing with this view, Dr. I.D. Gupta further pointed out that for calculation of horizontal seismic co-efficient, the normalized spectra should not be used, and the PGA value should be obtained directly from the actual response spectral amplitudes. Other Members of the Committee also agreed with the view points of Sh. Sibal and Dr. I.D. Gupta.

Extracts from the Engineer Manual published by US Army Corps of Engineers on "*Developing Standard Responses Spectra and Effective Peak Ground Accelerations for Use in the Design and Evaluation of Civil Works Projects" (Publication No. EM110- 2-6053, Appendix B, dated 1May, 2007)* were also placed by Sh. Sibal before the Committee ***(Annexure-II)***. Attention of the Committee was drawn to the methodology recommended in the Manual for calculation of the horizontal seismic co-efficient by using effective peak ground acceleration (EPGA) for a given return period corresponding to 5% damping. It was noted by the Committee that for a given return period and desired damping, the EPGA is being determined by dividing the corresponding short period spectral acceleration value by 2.5, and then the horizontal seismic co-efficient is arrived at by taking 2/3rd of the EPGA value. After applying this methodology of calculating the horizontal seismic co-efficient on few cases (under consideration of NCSDP) related to concrete as well as embankment dams, the Committee expressed satisfaction with the methodology.

The Committee also looked into the issue of computation of vertical co-efficient and after a brief deliberation decided that the same shall be taken as 2/3rd of the horizontal seismic co-efficient. The Committee observed that the now agreed approach for computation of horizontal and vertical seismic co-efficients will suffice only for the preliminary design of dams. As such the requirement of separate horizontal and vertical response spectra is not to be dispensed with, as these will be still required for the dynamic analysis of the dams.

Based on the above discussion, the CWPRS Pune and IIT Roorkee were requested by the Committee to provide the revised seismic design co-efficients along with design response spectra for the projects now placed before the Committee. (*Accordingly, IIT, Roorkee vide their letter no. EQD/NCSDP/823 dated 29.07.2013 and CWPRS, Pune vide their letter no. 322/193/VT/2007 dated 07.08.2013/14.08.2013 have furnished their responses and the same are given as* ***Annexure-III and Annexure-IV*** *respectively).*

The Committee also requested Dr. I.D. Gupta to provide the draft of amendments to the NCSDP guidelines (Oct, 2011) on account of above discussions and incorporating the below listed decisions:

(a) The horizontal seismic co-efficient (α_h) shall be calculated using effective peak ground acceleration (EPGA). For a given return period and desired damping, the EPGA is determined by dividing the corresponding short period spectral acceleration value by 2.5. The horizontal seismic co-efficient is then arrived at by taking 2/3rd of the EPGA value.

(b) For the calculation of horizontal seismic co-efficient, the normalized spectra should not be used, and the PGA value should be obtained directly from the actual response spectral amplitudes.

(c) Vertical seismic co-efficient (α_v) shall be taken as 2/3rd of the horizontal seismic co-efficient.

25.1 CONFIRMATION OF THE MINUTES OF THE LAST MEETING

Member Secretary informed that the Minutes of the 24th Meeting of NCSDP held on 15th March, 2013 were circulated to the Members of the Committee; and no observation/ comment on the circulated Minutes have been received by the Secretariat. He also informed that relevant extracts from the Minutes of Meeting were also sent to the concerned project authority for information.

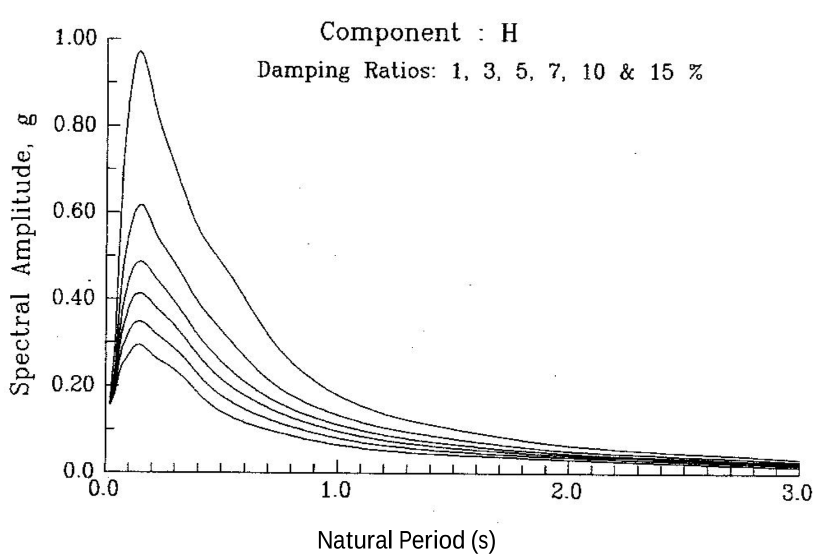
The Committee confirmed the Minutes of the 24th Meeting as circulated.

25.2 AGENDA ITEMS CARRIED OVER FROM PREVIOUS MEETINGS

25.2. 1. Halon Project, Madhya Pradesh

A presentation on the study report was made by the project authorities. The project response dated 12.06.2013 on compliances to the observations of 23rd NCSDP meeting held on 20th November, 2012 was also circulated in the Meeting ***(Annexure-V).*** **The Committee in light of its earlier deliberation (General), approved the study report of Halon Project, Madhya Pradesh incorporating the revised seismic design parameters as summarized below:**

(a) Response Spectra



The MCE level of smoothed design response spectra with damping ratios of 1,3,5,7,10 and,15% for horizontal components of motion. The DBE level of design spectra shall be taken as one half of the MCE level of spectra.

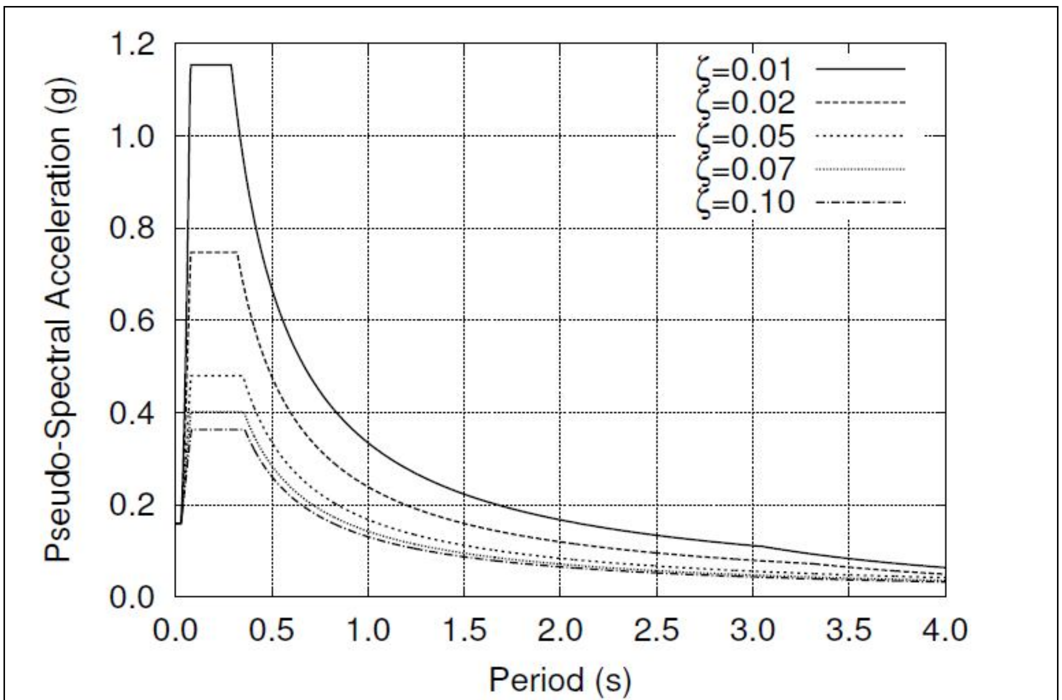
(b) Other seismic parameters

Max. Credible Earthquake Magnitude	6	Epicentral distance (km)	8.5	Focal depth (km)	25
Horizontal seismic co-efficient (α_h)	Earthen dam	0.04	Vertical seismic co-efficient (α_v)	Earthen dam	0.03
	Spillway Section (Conc)	0.06		Spillway Section (Conc)	0.04
Strong Motion duration (Sec)		6.83	Total duration (Sec)		40
Report reference	CWPRS Technical Report No. 4555 May, 2008 along with letter dated 07.08.2013 and 14.08.2013 indicating revised/additional parameters.				

25.2.2. Rupsiabagar Khasiabara H.E. Project, Uttarakhand

A presentation on the study report was made by the project authorities. **The Committee in light of its earlier deliberation (General), approved the study report of Rupsiabagar Khasiabara H.E. Project, Uttarakhand incorporating the revised seismic design parameters as summarized below:**

(a) Response Spectra



Spectra for DBE motion (Rupsiabagar Khasiyabara HEP)

(b) Other seismic parameters

Max. Credible Earthquake Magnitude	8	Distance to Zone of Energy Release (km)	15	Focal depth (km)	15
Horizontal seismic co-efficient (α_h)	0.13	Vertical seismic co-efficient (α_v)	0.09		
Strong motion duration (sec)	12 sec				
Report reference	IIT Roorkee's Report No. EQD-3016/2007-08 (April-2008) along with letter dated 29.07.2013 indicating revised parameters.				

25.2.3 Pench Valley Group Water Supply Scheme, Madhya Pradesh

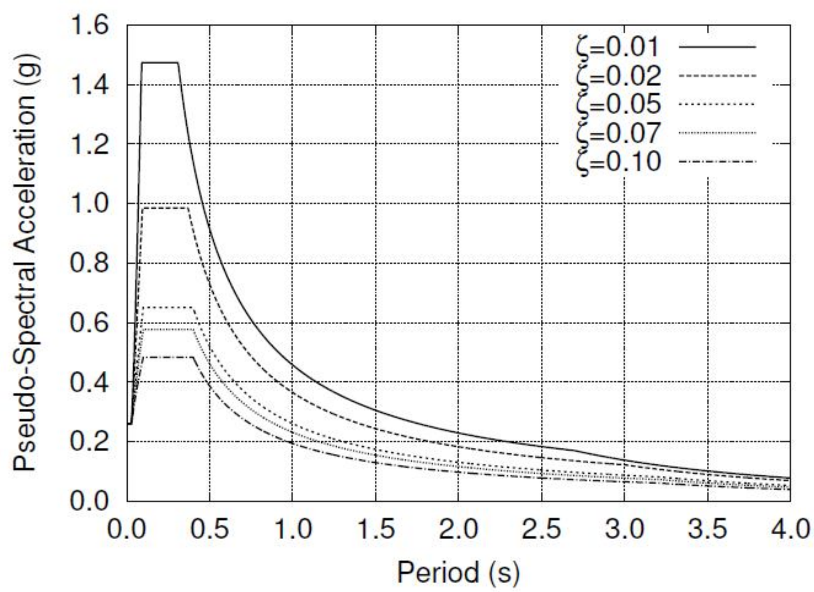
No representative of the project authority was available for making the presentation. The Committee noted that the project authorities have also not responded to the past several communications of the Secretariat seeking response to the observations raised by the Committee during 22nd NCSDP meeting held on 24th September, 2010. **Accordingly Committee decided to de-list the project from the agenda items of NCSDP meeting.**

25.2.4 Dikhu H.E. Project, Nagaland

A presentation on the study report was made by the project authorities. The project authorities informed that the MEQ studies have been taken up with installation of five broadband, three component seismographs around the Dikhu dam site. The project authorities presented the events recorded for the period of 19th April to 31st May, 2013 within 50 km radius w.r.t dam site. The number of seismic events recorded were 83 with magnitude range of 0-4.9 and depth range was 0.8 to 200.7 km. The project authorities informed that the final study report will be submitted latest by July, 2014. Member Secretary pointed out that overall report with addendum is highly segmented which needs to be recompiled in a single volume and the same shall be submitted in the Secretariat for record. This was agreed by the project authorities.

The Committee in light of its earlier deliberation (General) and subject to fulfillment of the commitment agreed by the project authority, approved the study report of Dikhu H.E. Project, Nagaland incorporating the revised seismic design parameters as summarized below:

(a) Response Spectra



Spectra for DBE motion (Dikhu HEP)

(b) Other seismic parameters

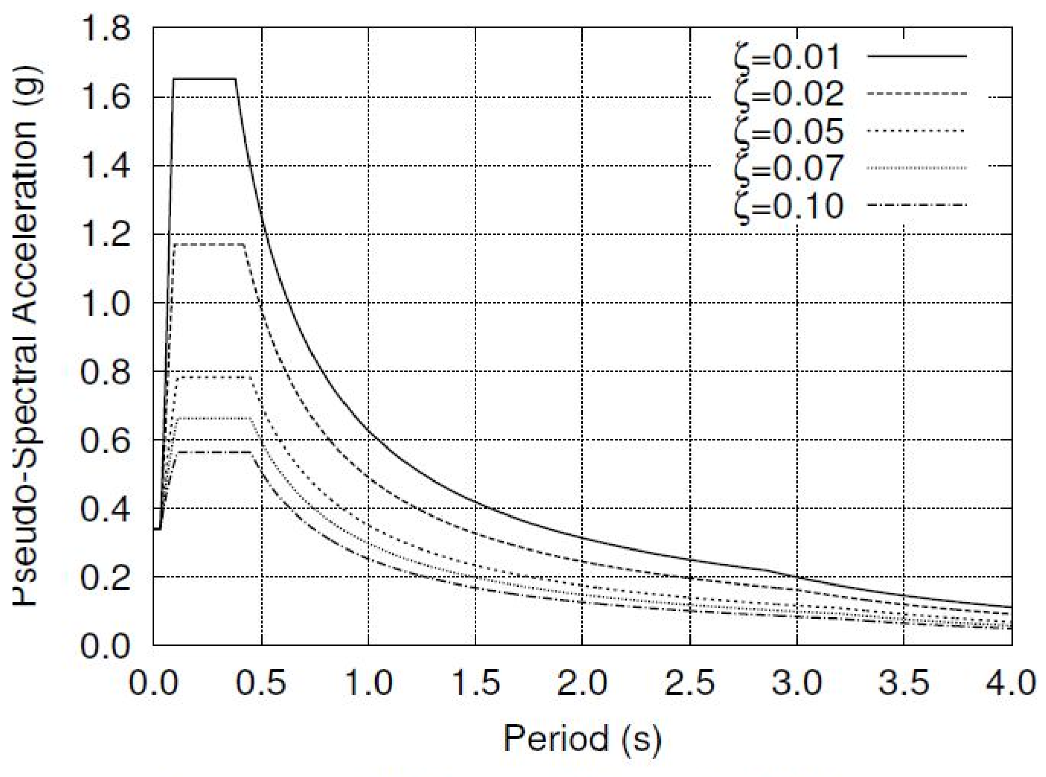
Max. Credible Earthquake Magnitude	7	Epicentral distance (km)	5	Focal depth (km)	15
Horizontal seismic co-efficient (α_h)	Dam (Rock-filled)	0.13	Vertical seismic co-efficient (α_v)	Dam (Rock-filled)	0.09
	Conc. Spillway	0.17		Conc. Spillway	0.12
Strong motion duration (sec)		13			
Report reference	IIT Roorkee Report No. EQD-3006/11-12 (July-2012) along with letter dated 29.07.2013 indicating revised parameters.				

25.3 NEW PROJECTS CONSIDERED FOR APPROVAL OF THE COMMITTEE

23.3.1 Rongnichu HE Project, Sikkim

A presentation on the study report was made by the project authorities. **The Committee in light of its earlier deliberation (General), approved the study report of Rongnichu HE Project, Sikkim incorporating the revised seismic design parameters as summarized below:**

(a) Response Spectra



Spectra for DBE motion (Rongnichu HEP)

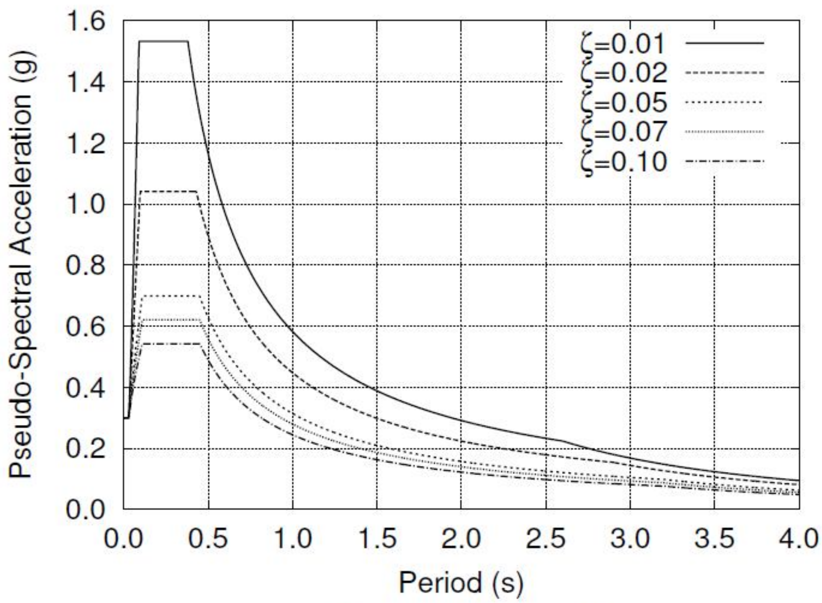
(b) Other seismic parameters

Max. Credible Earthquake Magnitude	8.0	Epicentral distance (km)	4	Focal depth (km)	15
Horizontal seismic co-efficient (α_h)		0.21		Vertical seismic co-efficient (α_v)	0.14
Report reference	IIT Roorkee Report No. EQ: 2012-32 [(Project No. EQD-6005/2012-2013(October-2012)] along with letter dated 29.07.2013 indicating revised parameters.				

25.3.2 Gongri HE Project, Arunachal Pradesh

A presentation on the study report was made by the project authorities. **The Committee in light of its earlier deliberation (General), approved the study report of Gongri HE Project, Arunachal Pradesh incorporating the revised seismic design parameters as summarized below:**

(a) Response Spectra



Spectra for DBE motion (Gongri HEP)

(b) Other seismic parameters

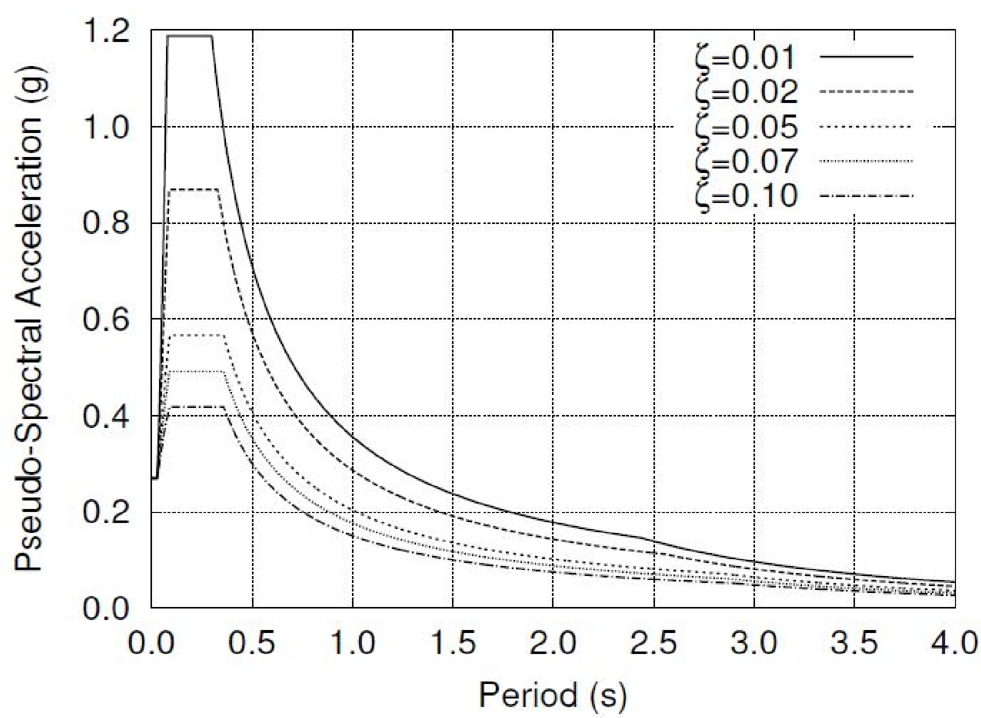
Max. Credible Earthquake Magnitude	8.0	Epicentral distance (km)	5	Focal depth (km)	15
Horizontal seismic co-efficient (α_h)	0.19	Vertical seismic co-efficient (α_v)	0.13		
Report reference	IIT Roorkee Report No. EQ: 2012-24 [(Project No. EQD-3016/2011-2012 (September-2012)] along with letter dated 29.07.2013 indicating revised parameters.				

25.3.3 Ratle HE Project, Jammu & Kashmir

A presentation on the study report was made by the project authorities. The project authorities have informed that MEQ studies for 133m high concrete dam have been planned in association with IIT Roorkee, and final study report will be submitted latest by July, 2014.

The Committee in light of its earlier deliberation (General) and subject to fulfillment of the commitment agreed by the project authority, approved the study report of Ratle HE Project, Jammu & Kashmir incorporating the revised seismic design parameters as summarized below:

(a) Response Spectra



Spectra for DBE motion (Ratle HEP)

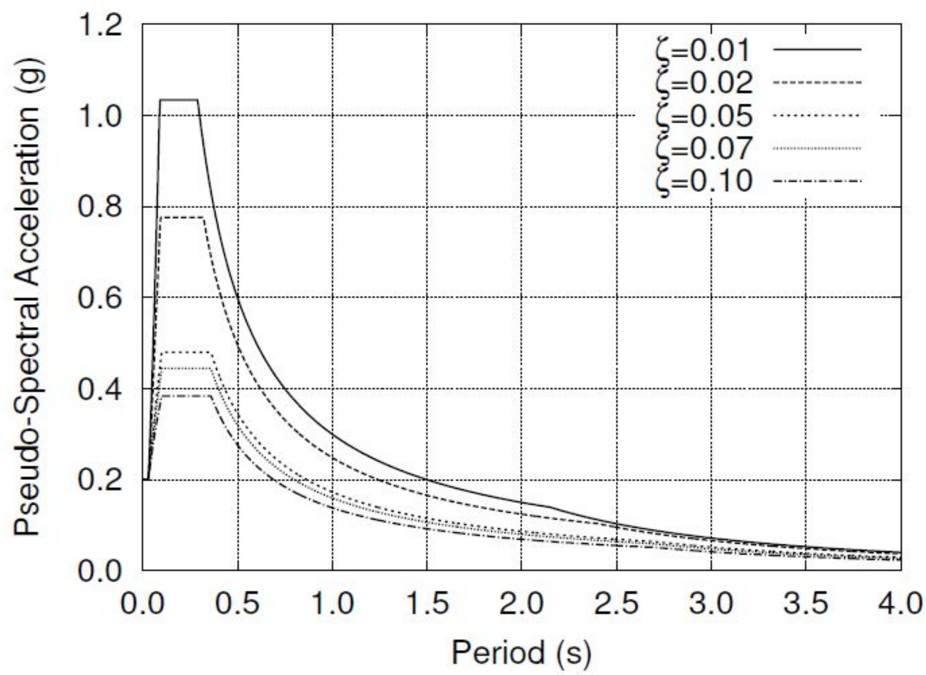
(b) Other seismic parameters

Max. Credible Earthquake Magnitude	7.5	Epicentral distance (km)	5	Focal depth (km)	15
Horizontal seismic co-efficient (α_h)		0.15	Vertical seismic co-efficient (α_v)		0.10
Strong motion duration (sec)		8			
Report reference	IIT Roorkee Report [Project No. EQD-6008/12-13 (January -2013)] along with letter dated 29.07.2013 indicating revised parameters.				

25.3.4 Rangit-II H.E. Project, Sikkim

A presentation on the study report was made by the project authorities. **The Committee in light of its earlier deliberation (General), approved the study report of Rangit-II H.E. Project, Sikkim incorporating the revised seismic design parameters as summarized below:**

(a) Response Spectra



Spectra for DBE motion (Rangit-II HEP)

(b) Other seismic parameters

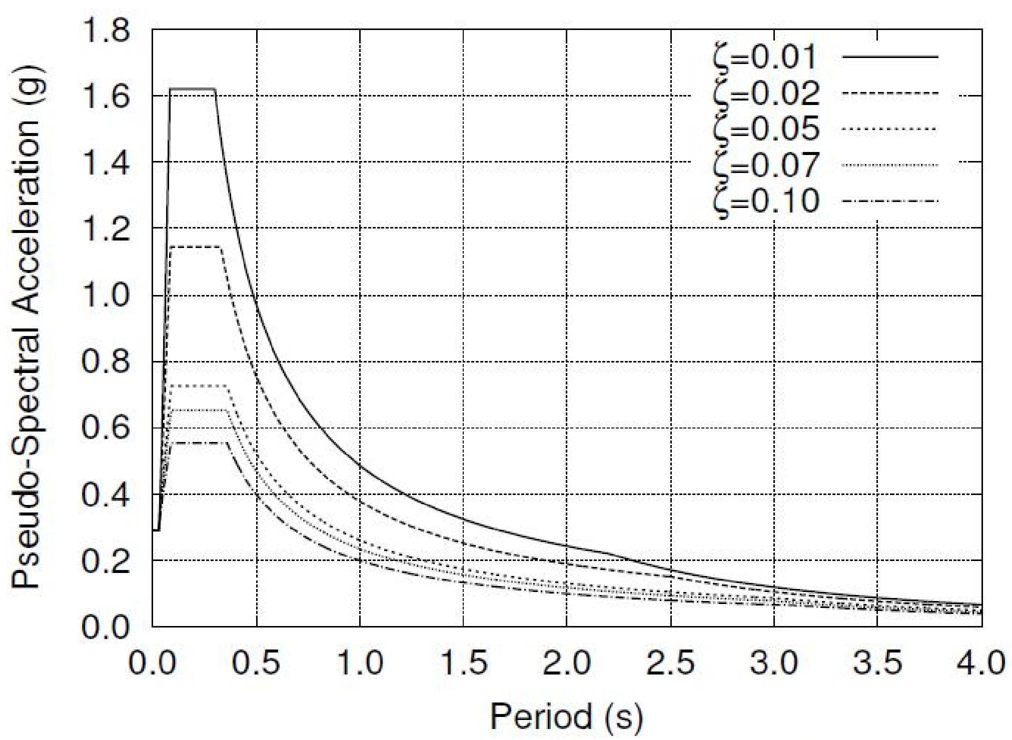
Max. Credible Earthquake Magnitude	7.5	Epicentral distance (km)	5	Focal depth (km)	15
Horizontal seismic co-efficient (α_h)	0.13	Vertical seismic co-efficient (α_v)	0.09		
Report reference:	IIT Roorkee Report No. EQ: 2012-10 [(Project No. EQD-3011/11-12 (April-2012)] along with letter dated 29.07.2013 indicating revised parameters.				

25.3.5 Thana Plaun HEP, Himachal Pradesh

A presentation on the study report was made by the project authorities. The project authorities have informed that the MEQ studies for 106.7 m high concrete dam will be taken up in association with IIT Roorkee and final study report will be submitted latest by July, 2014.

The Committee in light of its earlier deliberation (General) and subject to fulfillment of the commitment agreed by the project authority, approved the study report of Thana Plaun HEP, Himachal Pradesh incorporating the revised seismic design parameters as summarized below:

(a) Response Spectra



Spectra for DBE motion (Thana Plaun HEP)

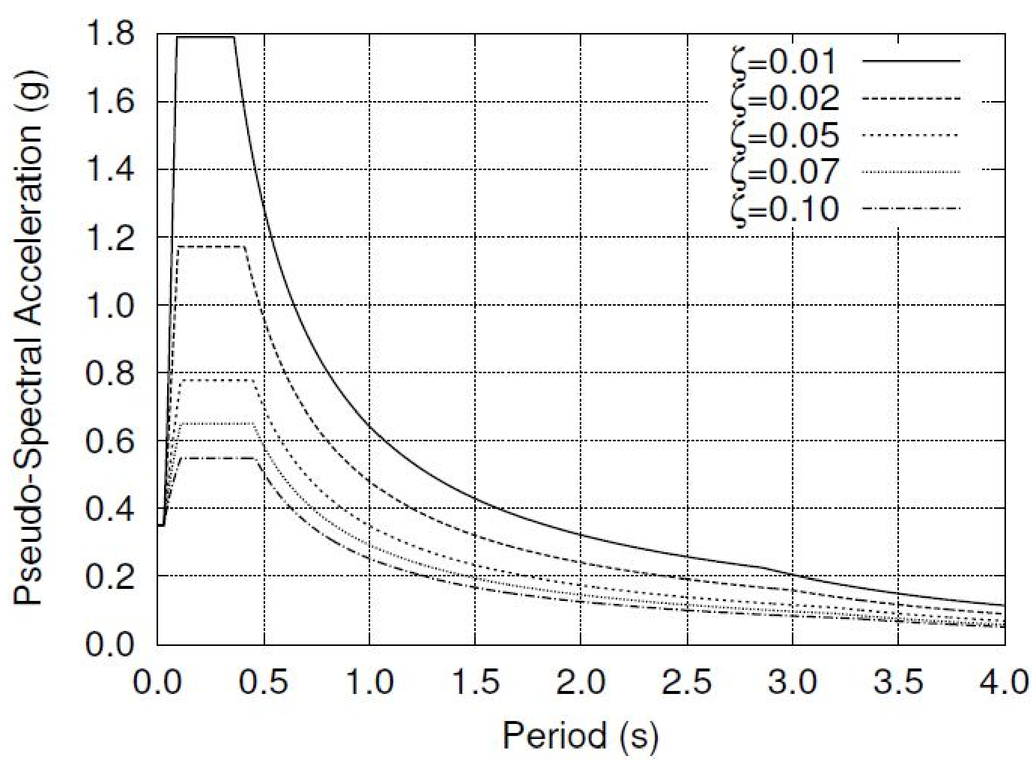
(b) Other seismic parameters

Max. Credible Earthquake Magnitude	7.0	Epicentral distance (km)	5	Focal depth (km)	15
Horizontal seismic co-efficient (α_h)	0.19	Vertical seismic co-efficient (α_v)	0.13		
Report reference	IIT Roorkee Report No. EQ: 2012-23 [(Project No. EQD-3013/2010-2011, (August, 2012)] along with letter dated 29.07.2013 indicating revised parameters				

25.3.6 Shongtong-Karcham HEP, Himachal Pradesh

A presentation on the study report was made by the project authorities. **The Committee in light of its earlier deliberation (General), approved the study report of Shongtong-Karcham HEP, Himachal Pradesh incorporating the revised seismic design parameters as summarized below:**

(a) Response Spectra



Spectra for DBE motion (Shongtong Karcham HEP)

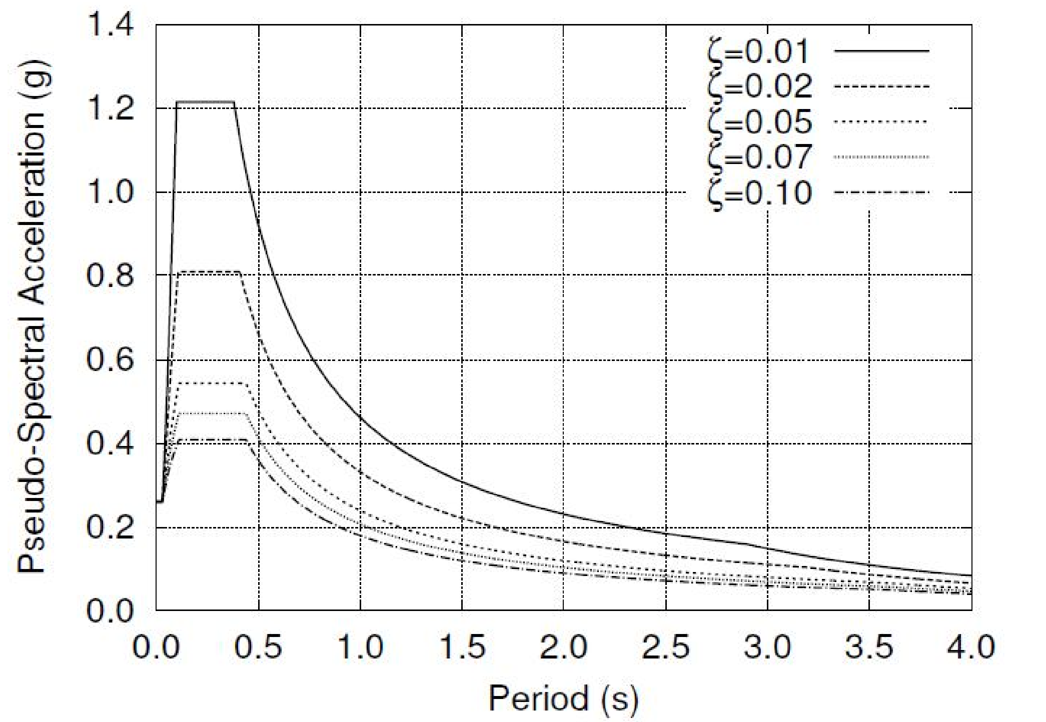
(b) Other seismic parameters

Max. Credible Earthquake Magnitude	8.0	Epicentral distance (km)	3	Focal depth (km)	15
Horizontal seismic co-efficient (α_h)		0.21	Vertical seismic co-efficient (α_v)		0.14
Strong motion duration (sec)		19			
Report reference	IIT Roorkee Report No. EQ: 2013-07 [(Project No. EQD-6027/2012-2013, (April, 2013)] along with letter dated 29.07.2013 indicating revised parameters.				

25.3.7 Miyar HEP, Himachal Pradesh

A presentation on the study report was made by the project authorities. **The Committee in light of its earlier deliberation (General), approved the study report of Miyar HEP, Himachal Pradesh incorporating the revised seismic design parameters as summarized below:**

(a) Response Spectra



Spectra for DBE motion (Miyar HEP)

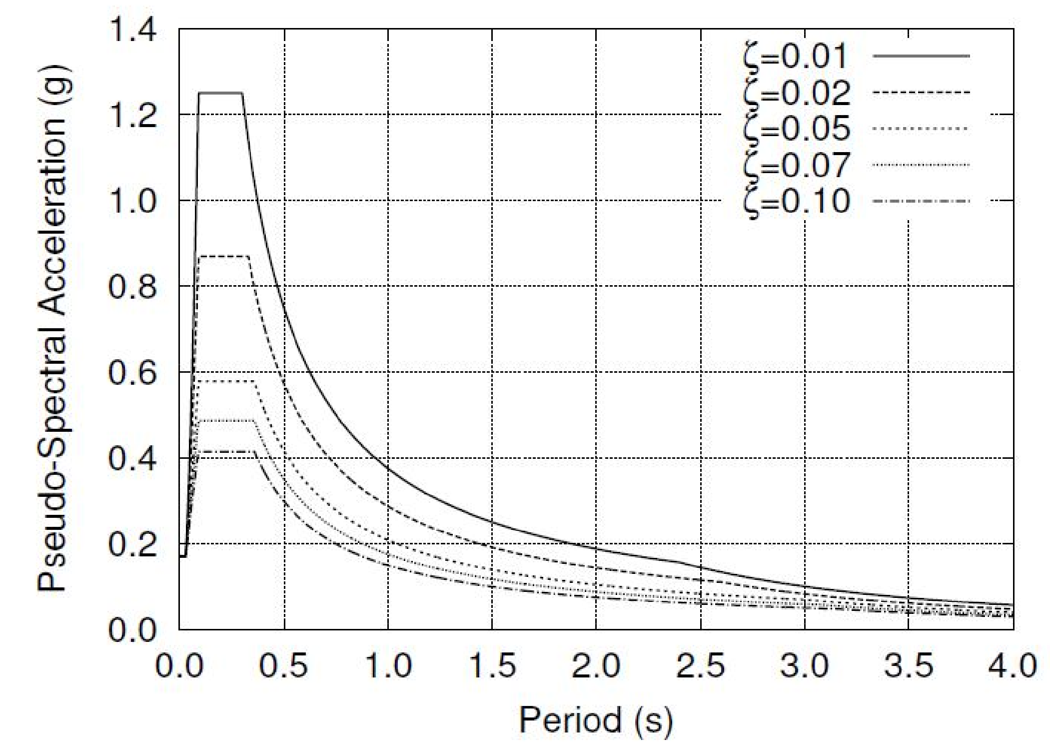
(b) Other seismic parameters

Max. Credible Earthquake Magnitude	8.0	Epicentral distance (km)	8	Focal depth (km)	15
Horizontal seismic co-efficient (α_h)		0.14	Vertical seismic co-efficient (α_v)		0.10
Strong motion duration (sec)		16			
Report reference	IIT Roorkee Report No. EQ: 2013-09 [(Project No. EQD-6009/2012-2013, (May, 2013)] along with letter dated 29.07.2013 indicating the revised parameters.				

25.3.8 Nyukcharong Chu HEP, Arunachal Pradesh

A presentation on the study report was made by the project authorities. **The Committee in light of its earlier deliberation (General), approved the study report of Nyukcharong Chu HEP, Arunachal Pradesh incorporating the revised seismic design parameters as summarized below:**

(a) Response Spectra



Spectra for DBE motion (Nyukcharong HEP)

(b) Other seismic parameters

Max. Credible Earthquake Magnitude	8.0	Epicentral distance (km)	5	Focal depth (km)	15
Horizontal seismic co-efficient (α_h)	0.15	Vertical seismic co-efficient (α_v)	0.10		
Report reference	IIT Roorkee Report No. EQ: 2011-29 [(Project No. EQD-3002/10-11 & 3007/11-12; August 2011)] along with letter dated 29.07.2013 indication the revised parameters.				

25.4 COMPOSITION AND TERMS OF REFERENCE (TOR) OF NCSDP- NEED FOR REVIEW

The responses received from Commissioner (SP) MoWR, Survey of India and Geological Survey of India were circulated in the meeting and the same are given as ***Annexure-VI***, ***Annexure-VII*** and ***Annexure-VIII*** respectively. **It was felt by the Committee that the suggestions/recommendations by the other Members of the Committee should also be forwarded to the Secretariat for earliest consideration of the Committee.**

25.5 ADDITIONAL AGENDA ITEMS WITH THE PERMISSION TO THE CHAIR

25.5.1 Kharkai dam Project, Jharkhand

Chief Engineer (N&W), CWC raised the issue of seismic design parameters of Kharkai dam which has come to CWC for design consultancy. Member Secretary informed that the project was considered by the then Standing Committee in its 9^{th} meeting held on 26.03.1974 under Subarnarekha Project (Chandil dam, Kharkai dam) along with other projects in Bihar, and wherein the Committee recommended design seismic co-efficient of 0.07g for masonary and 0.10g for earth dams uniformly for all the projects tentatively.

After the brief deliberation, the Committee decided that the earlier recommended design seismic co-efficient may be used for preliminary design, and an updated site specific seismic study report as per new guidelines may also be submitted for consideration of the Committee.

The meeting ended with vote of thanks to the chair.

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Summary of Policy related decisions of 25th NCSDP meeting:

(a) The approved design response spectra shall be incorporated in the minutes of the meeting in place of PGA values.

(b) The horizontal seismic co-efficient (α_h) shall be calculated using effective peak ground acceleration (EPGA). For a given return period and desired damping, the EPGA is determined by dividing the corresponding short period spectral acceleration value by 2.5. The horizontal seismic co-efficient is then arrived at by taking 2/3rd of the EPGA value.

(c) For the calculation of horizontal seismic co-efficient, the normalized spectra should not be used, and the PGA value should be obtained directly from the actual response spectral amplitudes

(d) Vertical seismic co-efficient (αv) shall be taken as 2/3rd of the horizontal seismic co-efficient.

(e) The above agreed approach for computation of horizontal and vertical seismic co-efficients will suffice only for the preliminary design of dams. As such the requirement of separate horizontal and vertical response spectra is not to be dispensed with, as these will be still required for the dynamic analysis of the dams.

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Annexure –I (A)

25th Meeting of National Committee on Seismic Design Parameters (NCSDP) on River Valley Projects

List of Participants on 28.06.2013

Sl.No.	Name & Address	Designation	Deptt./ Org.	Status/ Representative
I. Committee Members				
1.	Sh. A.B.Pandya	Member (D&R)	CWC, New Delhi	Chairman, NCSDP
2.	Sh. Pradeep Kumar	Commissioner (PR)	MoWR	Member
3.	Sh. L.A.V. Nathan	Chief Engineer (DSO)	CWC, New Delhi	Member
4.	Dr. I. D. Gupta	Director	CWPRS, Pune	Member
5.	Dr. M.L. Sharma	Professor & Head Deptt. of Earthquake Engg.	DEQ, IIT Roorkee,	Member
6.	Dr. Rajesh Prakash	Scientist 'E'	IMD Delhi	Representative of IMD
7.	Sh. Niroj Kumar Sarkar	Superintending Geologist	GSI, Shillong	Representative of GSI
8.	Sh. Upendra Nath Mishra	Director, Geodetic & Research branch	Survey of India Dehradun,	Representative of Survey of India
9.	Dr. B. R. K. Pillai	Director, FE&SA	CWC, New Delhi	Member-Secy. NCSDP
II. Special Invitees and other officials				
10.	Sh. S.K. Sibal	Director	CWC	CWC
11.	Dr. Manish Shrikhande	Assoc. Professor	DEQ, IIT Roorkee	IIT Roorkee
12.	Dr. J. Das	Scientist	DEQ, IIT Roorkee	IIT Roorkee
13.	Sh. O.P. Gupta	Deputy Director	CWC	NCSDP Secretariat
14.	Sh. Saurabh	Asst. Director	CWC	‘ ’
15.	Sh. G. Sanjeeva Reddy	Asst. Director II	CWC	“
16.	Sh. C.L. Premi	Head Draftsman	CWC	“
III. Project Representatives and Consultants				
17.	Sh. S.K.Baghel	Executive Engineer	NVDA	Halon Project, Madhya Pradesh
18.	Sh. R.K. Lachiya	Sub Engineer	NVDA	-Do-
19.	Sh. I. Rama Rao	Representative	Manu Energy	Dikhu HEP, Nagaland
20.	Dr. Prabhas Pande	Consultant	-Do-	-Do-
21.	Ms. Mugdha Patwardhan	Engineer	-Do-	-Do-
22.	Sh. Yogendra Deva	Representative	-Do-	-Do-
23.	Sh. S.,K. Garg	Representative	-Do-	-Do-
24.	Sh. B.M. Goswami	Director & CEO	Madhya Bharat Power Corp.	Rongnichu HEP, Sikkim
25.	Sh. S.S. Narang	Consultant	-Do-	-Do-
26.	Sh. Shantanu Rajbongshi	Sr. Engineer	-Do-	-Do-
27.	Sh. Purnendu Sinha	Representative	CES	Rongnichu HEP, Sikkim
28.	Sh. N.N. Pande	Representative	Dirang Energy	Gongri HEP, Arunachal Pradesh
29.	Sh. N.C. Chakraborty	Representative	-Do-	-Do-

30.	Sh. B.K. Shome	Representative	-Do-	-Do-
31.	Sh. P. Sinha	Representative	-Do-	-Do-
32.	Sh. M.M. Madan	Director	GVK	Ratle HEP, J&K
33.	Sh. Debashis Ghosh	Representative	-Do-	-Do-
34.	Sh. Rajeev Kumar	Representative	-Do-	-Do-
35.	Sh. G.S. Rayudu	Representative	-Do-	-Do-
36.	Sh. Naveen	Representative	-Do-	-Do-
37.	Sh. A.P. Singh	Representative	-Do-	-Do-
38.	Sh. David Cameron	Representative	-Do-	-Do-
39.	Sh. Vinod Kumar	Representative	SHPVL	Rangit-II HEP, Sikkim
40.	Sh. O.P. Singhal	Representative	-Do-	-Do-
41.	Sh. H.M. Dayar	Representative	-Do-	-Do-
42.	Sh. V.K. Pandey	Representative	-Do-	-Do-
43.	Sh. Sai Krishna	Representative	-Do-	Rangit-II HEP, Sikkim
45.	Sh. Nikesh Rai	Representative	-Do-	-Do-
46.	Sh. Ghanshyam	Representative	-Do-	-Do-
47.	Sh. Devendra Gautam	Representative	-Do-	-Do-
48.	Sh. Ajay Palyal	General Manager	HPPCL	Thana Plaun HEP, Himachal Pradesh
49.	Sh. D.S. Verma	Astt. General Manager	HPPCL	-Do-
50.	Sh. Rupok Sthepit	Sr. Associate Geologist	SMEC	-Do-
51.	Sh. Satish Kr. Sharma	Vice President	Moser Baer	Miyar HEP, Himachal Pradesh
52	Sh. Vivek Singh	Astt. General Manager	-Do-	-Do-
53.	Sh. Rakesh Kumar	Astt. General Manager	-Do-	-Do-
54	Sh. Amit Kumar	Officer	-Do-	-Do-
55.	Sh. V.R. Sharma	L.O.	SEW	Nyukcharong chu HEP, Arunachal Pradesh
56.	Sh. Rupok Sthepit	Sr. Associate Geologist	-Do-	-Do-
57.	Sh. Bhuvnesh Kumar	Dy. General Manager	NTPC	Rupsiabagar Khasiabara HEP, Uttarakhand
58.	Sh. S. Das	Manager	-Do-	-Do-
59.	Sh. P.M.K. Gandhi	Representative	-Do-	Ratle HEP, J&K
60.	Sh. Barad Sharma	Representative	-Do-	-Do-
61.	Sh. Subramaniam	Representative	-Do-	-Do-
62.	Sh. A.P. Singh	Representative	-Do-	-Do-
63.	Sh. Dawan	Representative	-Do-	-Do-
64.	Sh. Ajay Palyal	General Manager	HPPCL	Shongtong-Karcham HEP, Himachal Pradesh
65.	Sh. D.S. Verma	Astt. General Manager	HPPCL	-Do-

Annexure –I(B)

25th Meeting of National Committee on Seismic Design Parameters (NCSDP) on River Valley Projects

List of Participants on 08.07.2013

Sl.No.	Name & Address	Designation	Deptt./ Org.	Status/ Representative
I. Committee Members				
1.	Sh. A.B.Pandya	Member (D&R)	CWC, New Delhi	Chairman, NCSDP
2	Sh. L.A.V. Nathan	Chief Engineer (DSO)	CWC, New Delhi	Member
3.	Dr. I. D. Gupta	Director	CWPRS, Pune	Member
4.	Dr. Manish Shrikhande	Associate Professor	DEQ, IIT Roorkee,	Representative
5.	Sh. Niroj Kumar Sarkar	Superintending Geologist	GSI, Shillong	Representative of GSI
6.	Sh. R.K. Srivastava	Superintending Surveyor, Geodetic & Research Branch	Survey of India, Dehradun	Representative of Survey of India
7.	Dr. B. R. K. Pillai	Director, FE&SA	CWC, New Delhi	Member-Secy. NCSDP
II. Special Invitees and other officials				
8.	Sh. S.K.G. Pandit	Chief Engineer	CWC	CWC
9.	Sh. S.K. Sibal	Director	CWC	CWC
10.	Sh. Saibal Ghosh	Director	CWC	CWC
11.	Sh. O.P. Gupta	Deputy Director	CWC	NCSDP Secretariat
12.	Sh. Saurabh	Asst. Director	CWC	‘’
13.	Sh. G. Sanjeeva Reddy	Asst. Director II	CWC	“
14.	Sh. C.L. Premi	Head Draftsman	CWC	“

Appendix B
Developing Standard Response Spectra and Effective Peak Ground Accelerations for Use in the Design and Evaluation of Civil Works Projects

B-1. Introduction

a. Purpose. The purpose of this appendix is to provide a procedure for developing standard acceleration response spectra and effective peak ground accelerations for use in the seismic design and evaluation of structural features of USACE projects as required by ER 1110-2-1806. The standard response spectra can be used as a starting point for performing seismic designs and evaluations, and, if needed, for determining dynamic analysis requirements for more refined analysis. A specific goal of this appendix is to update previous guidance documents to include the information available in the 2000 National Earthquake Hazards Reduction Program (NEHRP) Recommended Provisions for New Buildings and Other Structures (FEMA 368), which are based on the most recent representation of the national ground shaking hazard.

b. Scope. Guidance is provided for using the most recent national seismic hazard data for determining both horizontal and vertical acceleration response spectra. Guidance is also provided for determining effective peak ground accelerations and seismic coefficients for use in seismic stability analyses.

c. Background. Previous guidance memoranda were prepared before the 2000 NEHRP Recommended Provisions were published. The recommended procedures in those documents were initially based on the spectral maps contained in the 1991 NEHRP provisions, and later on the maps contained in the 1994 NEHRP provisions. Over the years, there have been significant changes in the seismic hazards maps and their application to estimate ground shaking hazard levels. The 1997 NEHRP provisions introduced a more detailed procedure for estimating site specific design response spectra. The procedure in the current provisions is based on probabilistic estimates associated with a 2% probability of occurrence in 50 years bounded in some areas by deterministic thresholds, provide spectral ordinates at periods of 0.2 and 1.0 seconds. In addition, probabilistic seismic hazard information is currently available in the form of maps for peak ground acceleration and spectral ordinates at periods of 0.2 and 1.0 seconds which are available for probabilities of exceedance of 10% in 50 years and 2% in 50 years. Note that only the USGS probabilistic seismic hazard maps may be used in seismic design and evaluation of hydraulic structures, and not the MCDE maps. The MCDE maps are used in seismic design and evaluation of building structures and are mentioned here to provide background on NEHRP provisions.

d. Definitions

(1) Peak ground acceleration. The peak ground acceleration (PGA) is the maximum amplitude of the ground acceleration time history. In terms of structural response, it represents the peak value of the absolute acceleration of a single degree of freedom (SDOF) system with infinite stiffness, that is, with a natural period of vibration equal to zero.

(2) Effective peak ground acceleration and effective peak ground velocity.

(a) Several definitions and different physical interpretations have been proposed for this parameter with the purpose of quantifying the severity of design ground shaking. The concepts of effective peak acceleration (EPGA) and effective peak velocity (EPGV) have been employed to define design ground motions for use in model building codes. They were introduced in the Applied Technology Council (ATC-3 1978) seismic provisions as convenient normalizing factors for construction of design response spectra for ground motions of normal duration. The EPGA is proportional to spectral ordinates for periods in the range of 0.1 to 0.5 seconds, while the EPGV is proportional to spectral ordinates at a period of about 1 second. The constant of proportionality (for a 5 percent damping spectrum) was set at a standard value of 2.5 in both cases. The EPGA and EPGV are related to peak ground acceleration and peak ground velocity but are not necessarily the same as or directly proportional to peak acceleration and velocity. When very high frequencies are present in the ground motion, the EPGA may be significantly less than the peak ground acceleration. In general, if one examines the ratio between the spectral ordinate at period 0.2 seconds and the corresponding PGA value at individual locations in the national probabilistic hazard maps, the value of the ratio is variable and generally less than 2.5.

(b) Newmark and Hall (1982) characterized the effective peak acceleration as the acceleration value that is most closely related to structural response and to damage potential of an earthquake. That is, this concept of effective peak acceleration is intended to reflect the actual damage potential of the seismic excitation, which cannot be completely described only by the peak value of the ground acceleration. The definition of the effective peak acceleration therefore must take into account not only the amplitude of the excitation, but also of its frequency content and the type and characteristics of the general structural system under consideration.

(3) Response spectra.

(a) A response spectrum is a plot of the peak values of the response (displacement, velocity, or acceleration) of a number of SDOF systems with different natural vibration periods subjected to the same seismic input. Therefore, an acceleration response spectrum represents the peak accelerations that a suite of SDOF systems with a range of natural periods may exhibit for a given component of ground motion.

(b) In general, the acceleration response spectrum associated with a specific time history recorded at a given location has a jagged shape with significant peaks and valleys. The response spectrum for another ground motion recorded at the same site during a different earthquake will exhibit also an irregular shape, but the peaks and valleys will not necessarily coincide with those in the previous one.

(c) Therefore, appropriately smoothed spectra are usually defined for design and evaluation purposes. These spectra are termed design response spectra. They do not represent the acceleration response from a single ground motion time history, but rather they are intended to be representative of all the ground motions that can be expected at a given site. There are two basic approaches for the development of design response spectra: site-specific procedure or standard procedure.

(d) Site-specific response spectra. Site-specific response spectra are developed using source to site distances, appropriate attenuation relationships, expected magnitudes and actual local site conditions. Therefore, it is typically assumed that site specific studies will provide more accurate acceleration spectra than using the codified standard acceleration spectra. EM 1110-2-6050 describes the conditions requiring a site specific ground motion study. Site-specific response spectra can be generated by means of a deterministic seismic hazard analysis (DSHA) or a probabilistic seismic hazard analysis (PSHA). In the DSHA, the site ground motions are estimated for a specific earthquake, defined as a seismic event of a certain magnitude for a particular seismic source occurring at a certain distance from the site. The representation of the ground motions in terms of the corresponding site-specific response spectra is achieved by using appropriate attenuation relationships. Information on this approach can be found in EM 1110-2-6050. The PSHA is an approach that uses the likelihood (probability) that a given level of ground motion will occur during a specific exposure period. In the PSHA, the site ground motions are defined for selected values of the probability of exceedance in a given time exposure period, or for selected values of annual frequency or return period for ground motion exceedance. This approach incorporates the frequency of occurrence of earthquakes of different magnitudes on the seismic sources, the uncertainty of the earthquake locations on the sources, and the ground motion attenuation including its uncertainty. The response spectra developed by a PSHA represent equal or uniform hazard spectra, in which each spectral ordinate has an equal probability of exceedance. EM 1110-2-6050 describes the procedures for probabilistically estimating earthquake ground motions.

(e) Standard response spectra. Standard response spectra are based on a general characteristic shape that is defined in terms of estimates of selected ground motion parameters, which can be effective peak ground accelerations or spectral accelerations. EM 1110-2-6050 describes the approach proposed by Newmark and Hall (1982) to develop design response spectra using peak ground motion parameters (peak ground acceleration, velocity and displacement), multiplied by a series of appropriate spectral amplification factors that depend on the damping level.

(4) Probability of exceedance. The probability of exceedance represents the chance, expressed as a percentage (%), that a more severe ground motion will occur within a specified exposure time expressed in number of years. Assuming that the temporal occurrence of the earthquake follows a Poisson process, the probability of exceedance (P_e) in a given exposure time (T_e) is related to the annual probability of exceedance (λ_m) as follows:

$$P_e = 1 - e^{-\lambda_m T_e} \quad (1)$$

The reciprocal of the annual probability of exceedance is the return period ($T_R = 1/\lambda_m$), which represents the average number of years between exceedances. For a given (P_e, T_e) pair, the corresponding return period can be obtained as follows:

$$T_R = -\frac{T_e}{\ln(1 - P_e)} \quad (2)$$

As an example, an earthquake having a probability of exceedance of 2% in 50 years would have a mean return period of 2,475 years, whereas an earthquake having a probability of exceedance of 10% in 50 years would have a mean return period of 475 years. The following table summarizes the return periods for some of the most common combinations of probabilities of exceedance and exposure time:

Table B-1. Approximate return periods for different probabilities of exceedance and exposure times

Prob. of Exceedance	**Exposure Time** [years]	**Return Period** [years]
50%	100	144
10%	50	475
10%	100	950
5%	100	1,950
2%	50	2,475
1%	100	9,950

(5) Operating basis earthquake (OBE). The OBE is an earthquake that can reasonably be expected to occur within the service life of the project, that is, with a 50 percent probability of exceedance during the service life. (This corresponds to a return period of 144 years for a project with a service life of 100 years.) The associated performance requirement is that the project will show little or no damage without interruption of function. The purpose of the OBE is to protect against economic losses from damage or loss of service. Therefore alternative choices of return period for the OBE may be based on economic considerations. In a site-specific study the OBE is determined by a PSHA (ER 1110-2-1806).

(6) Maximum design earthquake (MDE). The MDE is the maximum level of ground motion for which a structure is designed or evaluated. The associated performance requirement is that the project performs without catastrophic failure, such as uncontrolled release of a reservoir, although severe damage or economic loss may be tolerated. The MDE can be characterized as a deterministic or probabilistic event (ER 1110-2-1806).

(7) Maximum credible earthquake (MCE). The maximum credible earthquake represents the earthquake hazard level used for design and evaluation of critical features of high hazard projects as defined by ER 1110-2-1806. The Maximum Credible Earthquake is defined as the greatest earthquake that can reasonably be expected to be generated by a specific source on the basis of the available seismological and geological evidence. The Maximum Credible Earthquake is determined by a deterministic seismic hazard analysis. Since buildings are not classified as critical facilities, the use of a Maximum Credible Earthquake as defined in ER 1110-2-1806 is not required for the building structures.

(8) Seismic coefficient method. In the seismic coefficient method, the inertial force is assumed to act in a horizontal direction at the center of mass of the structure, based on the assumption that the structure is a rigid body. However, the use of the rigid body concept often underestimates the magnitude of the actual inertial actions because of the amplification effects associated with the flexibility of the structure.

(9) Dynamic analysis procedures. Linear dynamic analysis procedures are presently used for earthquake-resistant design and safety evaluation of hydraulic structures. Linear dynamic analysis is typically based on modal decomposition techniques, in which the total response of a structure is obtained by combining the response of its individual modes of vibration, calculated separately. Linear dynamic analysis is adequate for structures whose seismic response stays within the linear elastic range and it can be performed using response spectrum analysis or time-history analysis.

(a) Response spectrum analysis. In the response spectrum analysis, the peak response of the structure is evaluated by combining estimates of the maximum responses from individual modes and multicomponent input. The seismic input is defined in terms of ground response spectra.

(b) Time history analysis. This type of analysis involves the computation of the complete response history of the structure to the earthquake, and not just the peak values. The seismic input is given by actual or simulated acceleration time histories.

B-2. Seismic hazard and design maps

a. USGS probabilistic maps. The U.S. Geological Survey (USGS) National Hazard Mapping Project supported by NEHRP provides the latest peer reviewed and published seismic hazard data for the US. This data is provided in probabilistic hazard maps and interactive web based query for certain ground motion parameters. The current link to this project site is located at the following address: http://eqhazmaps.usgs.gov/. However, this could change and it may be necessary to search for the most current web link. The available probabilistic maps for downloading or viewing correspond to PGA values and 0.2 sec and 1.0 sec spectral acceleration values for probabilities of exceedance of 10% in 50 years (return period of 475 years) and 2% in 50 years (return period of 2,475 years). The site also provides an interactive menu where the user can obtain the above mapped values for a given location specified by latitude / longitude. Ground motion values for the 48 states have been calculated for a grid spacing of 0.05 degrees. Interpolated values are typically calculated using the four surrounding corner points. For guidance, 0.1 degree latitude is about 6.8 miles, and 0.1 degree longitude varies but for the 48 states is on the order of 5.6 miles. Figures B-1 and B-2 show the probabilistic maps for the 0.2 and 1-second spectral acceleration values corresponding to a probability of exceedance of 2% in 50 years.

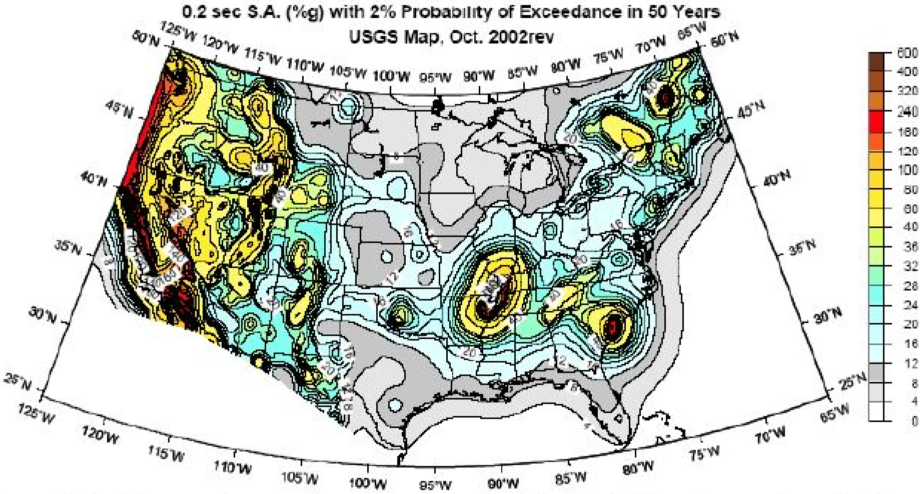


Figure B-1. 0.2-second spectral acceleration with 2% probability of exceedance in 50 years

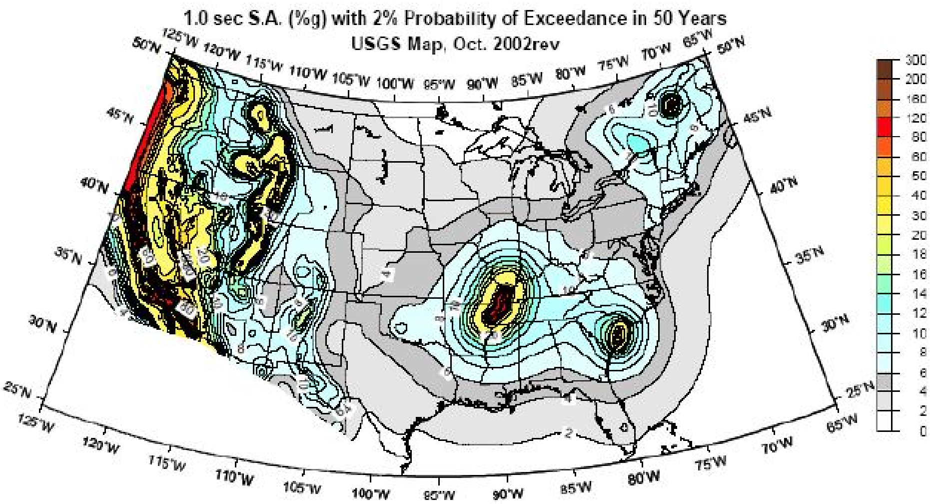


Figure B-2. 1-second spectral acceleration with 2% probability of exceedance in 50 years

b. MCE design maps. Most recent NEHRP provisions define seismic hazards in terms of "Maximum Considered Earthquake" ground motions, which are based on a set of rules that depend on the seismicity of a region. The design ground shaking level for new building structures is defined as 1/1.5 = 2/3 of the maximum considered earthquake ground motion. For most regions of the nation, the maximum considered earthquake ground motion is defined with a uniform probability of exceedance of 2% in 50 years (return period of about 2,500 years). For regions of high seismicity (such as coastal California) the seismic hazard is typically controlled by large-magnitude events occurring on a limited number of well-defined fault systems. The ground shaking calculated at a

2% PE / 50 years would be much larger than that which would be expected based on the characteristic magnitudes of earthquakes on these known active faults. For regions of high seismicity, it is more appropriate to directly determine the maximum considered earthquake motions based on the actual characteristics of these faults. The ground shaking in these cases is defined based on the median estimate of the ground motion resulting when the characteristic earthquake is multiplied by 1.5 to achieve the appropriate level of conservatism.

B-3. Development of standard horizontal response spectrum

a. Seismic hazard data. The following recommended procedure for developing standard spectra for use in the preliminary design and analysis of USACE civil works structures is based on the current probabilistic seismic hazard data. For a given site location, the spectral ordinates at periods of 0.2 and 1.0 seconds are available for probabilities of exceedance of 10% in 50 years and 2% in 50 years. These ground motion values are calculated for firm rock sites. The spectral ordinate at periods 0.2 and 1 seconds are denoted as S_S and S_1.

b. Site effects.

(1) The shape of the standard response spectra can be modified to reflect site characteristics. The effects of the soil and foundation conditions can greatly affect the structural response. These site effects are accounted for in the development of the standard response spectra by the use of site coefficients that scale the spectral ordinates to the appropriate values for other local conditions such as those defined in Table B-2.

(2) Site class F is omitted from the table because this site classification requires site-specific investigations and a standard response spectrum should not be employed for this case. The site coefficients F_a and F_v are given in Tables B-3 and B-4. These two coefficients F_a and F_v scale the values of S_S and S_1, respectively, which were determined for firm rock conditions (characterized by a shear-wave velocity of about 2,500 ft/sec in the top 100 ft).

(3) The independent scaling of the spectral parameters using these factors modifies not only the spectral amplitudes but also the shape of the spectrum by changing the maximum amplification plateau. The scaled maximum considered earthquake spectral values are designated as $\overline{S}_S$ and $\overline{S}_1$, for short and 1-second period responses. They are given by the following expressions:

$$\begin{aligned} \overline{S}_S &= F_a S_a \\ \overline{S}_1 &= F_v S_1 \end{aligned} \qquad (3)$$

Table B-2. Site classification

Site Class	Description
A	Hard rock with $\overline{v}_s > 5{,}000\,\text{ft/sec}$
B	Rock with $2{,}500\,\text{ft/sec} < \overline{v}_s \le 5{,}000\,\text{ft/sec}$
C	Very dense soil and soft rock with $1{,}200\,\text{ft/sec} < \overline{v}_s \le 2{,}500\,\text{ft/sec}$ or with either $\overline{N} > 50$ or $\overline{s}_u > 2{,}000\,\text{psf}$
D	Stiff soil with $600\,\text{ft/sec} \le \overline{v}_s \le 1{,}200\,\text{ft/sec}$ or with either $15 \le \overline{N} \le 50$ or $1{,}000\,\text{psf} \le \overline{s}_u \le 2{,}000\,\text{psf}$
E	A soil profile with $\overline{v}_s < 600\,\text{ft/sec}$ or with either $\overline{N} < 15$ or $\overline{s}_u < 1{,}000\,\text{psf}$, or any profile with more than 10 ft of soft clay

Table B-3. Site correction coefficient F_a

Site Class	Coefficient F_a				
	$S_S \le 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \ge 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9

Table B-4. Site correction coefficient F_v

Site Class	Coefficient F_v				
	$S_1 \le 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \ge 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4

c. Damping. The seismic hazard information is based on an inherent structural damping of 5%. If spectral values for other damping ratios are required, then the standard spectral accelerations have to be adjusted using the correction coefficients B_S and B_1 provided in Table B-5.

d. Construction of standard horizontal spectrum.

(1) To determine the standard horizontal response spectrum it is necessary to compute first the values of the two periods defining the interval of maximum spectral amplification. They are denoted as T_0 (start of maximum amplification plateau) and T_S (end of maximum amplification plateau), and they are defined as follows:

$$T_S = \frac{B_S \bar{S}_1}{B_1 \bar{S}_S} \qquad T_0 = \frac{1}{5} T_S \tag{4}$$

(2) The standard horizontal spectrum is then defined as follows:

$$S_A(T) = \begin{cases} \bar{S}_S\left(\left(\dfrac{5}{B_S} - 2\right)\dfrac{T}{T_S} + 0.4\right) & \text{for } 0 \le T < T_0 \\ \dfrac{\bar{S}_S}{B_S} & \text{for } T_0 \le T < T_S \\ \dfrac{\bar{S}_1}{B_1 T} & \text{for } T_S \le T \end{cases} \tag{5}$$

Table B-5. Damping correction coefficients B_S and B_1

Damping [%]	Coefficient B_S	Coefficient B_1
≤ 2	0.80	0.80
3	0.87	0.87
4	0.93	0.93
5	1.00	1.00
6	1.06	1.04
7	1.12	1.08
8	1.18	1.12
9	1.24	1.16
10	1.30	1.20
20	1.80	1.50

e. Spectrum construction for different probability levels

(1) The two values of spectral ordinates at periods of 0.2 and 1.0 seconds (S_S and S_1) are available for probabilities of exceedance of 10% in 50 years and 2% in 50 years, which correspond to average return periods of 475 and 2,475 years, respectively. If a standard spectrum associated with a different probability of exceedance or return period is required, then it is necessary to appropriately modify those values.

(2) It is assumed that the hazard curves relating the spectral acceleration (S_A) with the return period (T_R) can be approximated by power curve functions of the following form:

$$S_A = b(T_R)^m \tag{6}$$

This assumption implies that spectral values and return periods are linearly related in a log-log representation, that is:

$$\log(S_A) = \log(b) + m\log(T_R) \tag{7}$$

The coefficient m represents the slope of the straight line and $\log(b)$ is the intercept on the ordinate axis.

(3) Considering the available data points, which are represented by ($S_A^{T_R=475}$) and ($S_A^{T_R=2475}$), then it is possible to obtain spectral accelerations at different return periods by linear log-log interpolation. The curve coefficients are given by

$$\begin{aligned} m &= \frac{\log(S_A^{T_R=2475}) - \log(S_A^{T_R=475})}{0.7169} \\ \log(b) &= 4.7338\log(S_A^{T_R=475}) - 3.7338\log(S_A^{T_R=2475}) \end{aligned} \tag{8}$$

Using this approach, two approximated hazard curves can be defined for the spectral accelerations at periods of 0.2 and 1.0 seconds (S_S and S_1), which can be then used to determine the corresponding spectral values for other return periods different from 475 and 2,475 years.

B-4. Development of standard vertical response spectrum

a. Vertical-to-horizontal response spectral ratio. Vertical response spectra may be necessary for design and analysis of certain structures. The commonly adopted vertical-to-horizontal response spectral ratio of 2/3 (Newmark and Hall 1978) may be significantly exceeded at short periods for near-source distance conditions. Therefore, the vertical standard response spectrum should be obtained considering the source to site distance (R) by means of the factors given in Table B-6. These factors were based on the information provided in EM 1110-2-6050. In most cases of preliminary design the source-to-site distance will be unknown, and for those cases $R = 25\,\text{km}$ (15 miles) may be assumed. This general procedure can be applied to both standard and site-specific spectra, although in this last case vertical response spectra can also be derived directly by some attenuation relationships.

Table B-6. Conversion factor F_V for vertical response spectrum

Source to Site Distance (R)	Conversion Factor
≤ 10 km	1.00
25 km	0.84
≥ 40 km	0.67

b. Construction of standard vertical spectrum.

(1) To determine the standard spectrum it is necessary to compute first the period defining the upper limit of the maximum vertical amplification plateau, given by

$$T_{SV} = \frac{0.67}{F_V} T_S \tag{9}$$

(2) The standard vertical spectrum is then defined as follows:

$$S_{AV}(T) = \begin{cases} F_V\, S_A(T) & \text{for } T < T_{SV} \\ 0.67 \dfrac{\overline{S}_1}{B_1 T} & \text{for } T_{SV} \le T \end{cases} \tag{10}$$

B-5. Multi-component earthquake input

a. Second orthogonal component of horizontal ground motion. The NEHRP hazard maps are based on attenuation relationships for the random horizontal component of the ground motion, not the stronger component. If a second orthogonal component of horizontal motion is required for preliminary seismic analysis, then it should be set equal to the first orthogonal component determined as indicated in the previous section.

b. Combining multi-component earthquake input. For most structures, preliminary seismic analysis can be conducted considering a single horizontal component of earthquake ground motion. However, for those cases where the effects due to two or three components of ground motion must be taken into account, the maximum structural responses should be obtained by combining the effects of the components in accordance with the procedures described in EM 1110-2-6050.

B-6. Seismic stability analysis

a. Determination of effective peak ground acceleration (EPGA). For a given return period, the effective peak ground acceleration (EPGA) is determined by dividing by 2.5 the corresponding 5%-damping short period spectral acceleration value as follows:

$$EPGA(T_R) = \frac{\overline{S}_S^{T_R}}{2.5} \tag{12}$$

b. Seismic coefficient. The seismic coefficient used for the preliminary seismic stability evaluation of concrete hydraulic structures should be equal to 2/3 of the EPGA value corresponding to the OBE or the MDE, expressed as a decimal fraction of the acceleration of gravity.

B-7. DEQAS-R computer program

a. Description. Due to the availability of the national probabilistic seismic hazard data, it is now possible to provide tools to assist in developing design spectra without the need to manually extract data from maps or to explicitly query the USGS web site. A set of integrated software tools has been developed to provide the needed seismic hazard data based on the most recent national probabilistic seismic hazard information. For user-specified location and return period, the current version of this program can calculate and display the horizontal and vertical standard spectra based on the procedure provided in this document. In addition, the program can generate the equal hazard spectrum for the location and return period indicated as well as the corresponding seismic hazard curves for periods of 0.2 and 1.0 seconds. The program also includes additional options to display different maps containing the most recent seismic hazard data and it provides access to relevant USACE reference documents.

b. Availability. The program DEQAS-R can be downloaded from the following website: http://chl.erdc.usace.army.mil/.

B-8. Examples

Typical example problems illustrating step-by-step implementation of the procedures in this guidance document are provided in Appendix C. The first example describes the development of a 5%-damping horizontal standard spectrum for an OBE. The second example describes the development of both horizontal and vertical standard spectra for an MDE and for a 6% damping level. The last example describes the determination of EPGA values for a specified set of return periods. The solution of each one of these examples using the computer program DEQAS-R is illustrated in Section II of Appendix C.

Annexure-III

No. EQD/NCSDP/ 823
Date: July 29, 2013

Shri O.P. Gupta
Dy. Director,
FE&SA Dte,
Central Water Commission,
NCSDP Secretariat,
712(A), Sewa Bhawan, R.K. Puram,
NEW DELHI- 110 066

Sub: 25rd meeting of the NCSDP on 28 June, 2013 continued on July 8, 2013.

Dear Sir,

Please see the attached file for the requisite information as discussed in the meeting. Hope this helps. I am sorry for the delay.

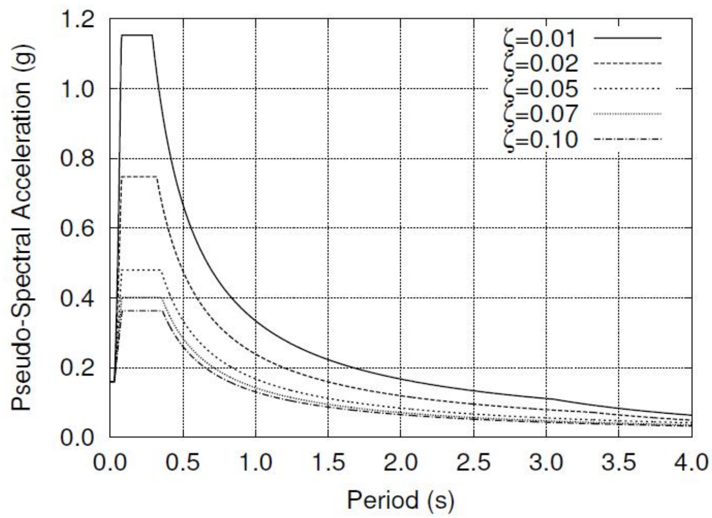
With best wishes,

Your sincerely,

(M.L. Sharma)

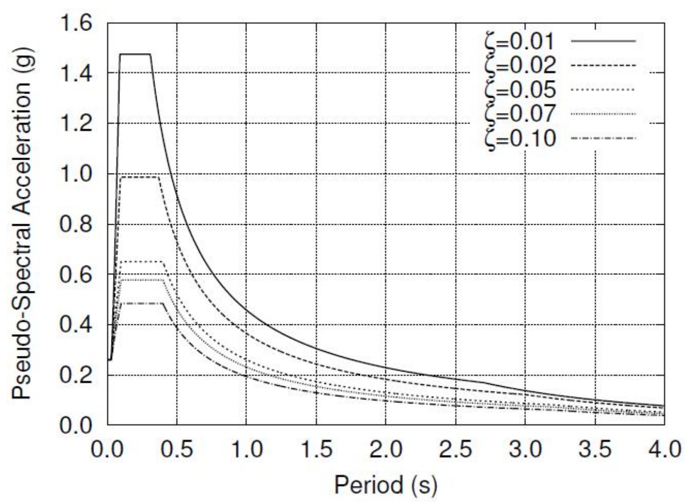
DR. M. L. SHARMA
Professor & Head
Department of Earthquake Engineering
Indian Institute of Technology Roorkee
Roorkee-247 667 Uttarakhand (INDIA)

Rupsiabagar Khasiyabara HEP The estimated seismic coefficients are: $\alpha_h = 0.13$ and $\alpha_v = 0.09$ and strong motion duration is 12 s.



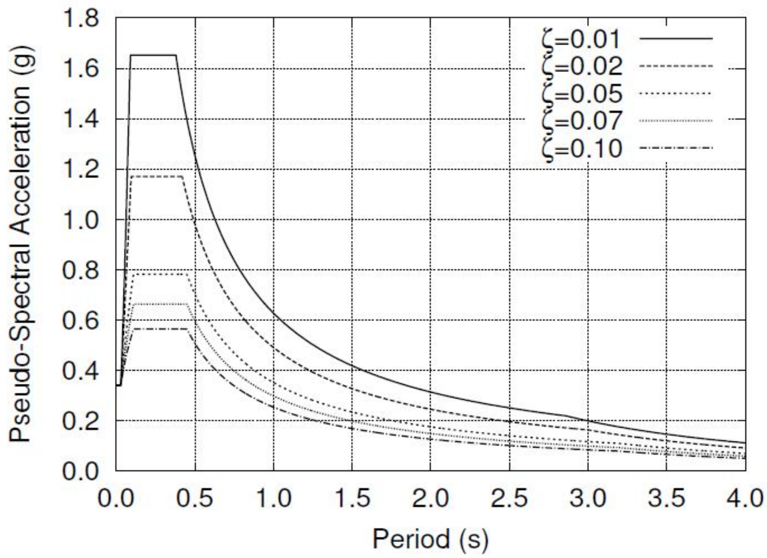
Spectra for DBE motion (Rupsiabagar Khasiyabara HEP)

Dikhu HEP The estimated seismic coefficients are: (a) for dam: $\alpha_h = 0.13$ and $\alpha_v = 0.09$, (b) for concrete spillway: $\alpha_h = 0.17$ and $\alpha_v = 0.12$ and the strong motion duration is 13 s.



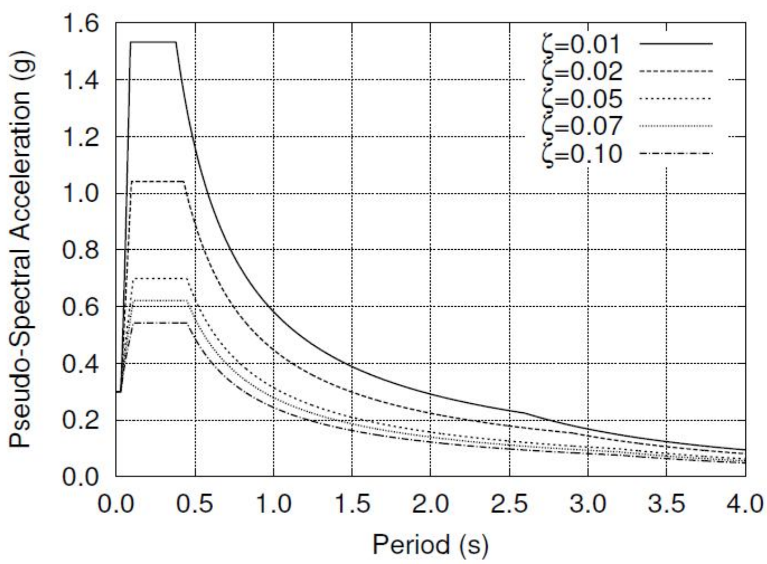
Spectra for DBE motion (Dikhu HEP)

Rongnichu HEP The estimated seismic coefficients are: $\alpha_h = 0.21$ and $\alpha_v = 0.14$



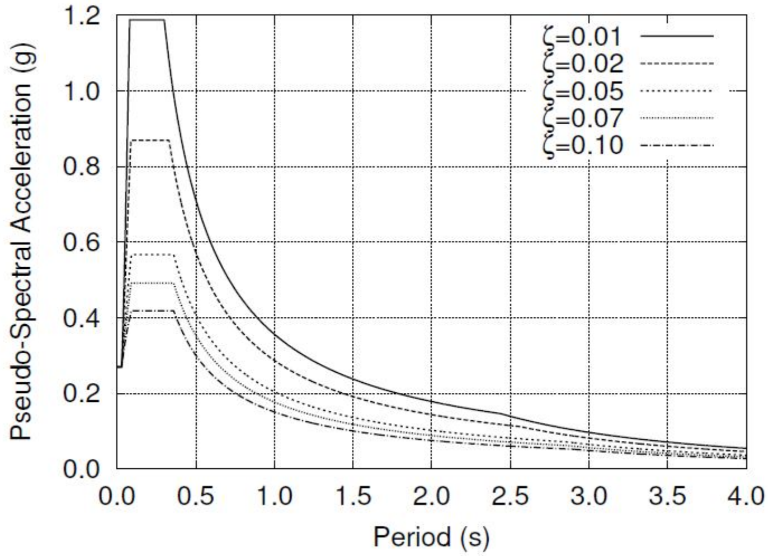
Spectra for DBE motion (Rongnichu HEP)

Gongri HEP The estimated seismic coefficients are: $\alpha_h = 0.19$ and $\alpha_v = 0.13$



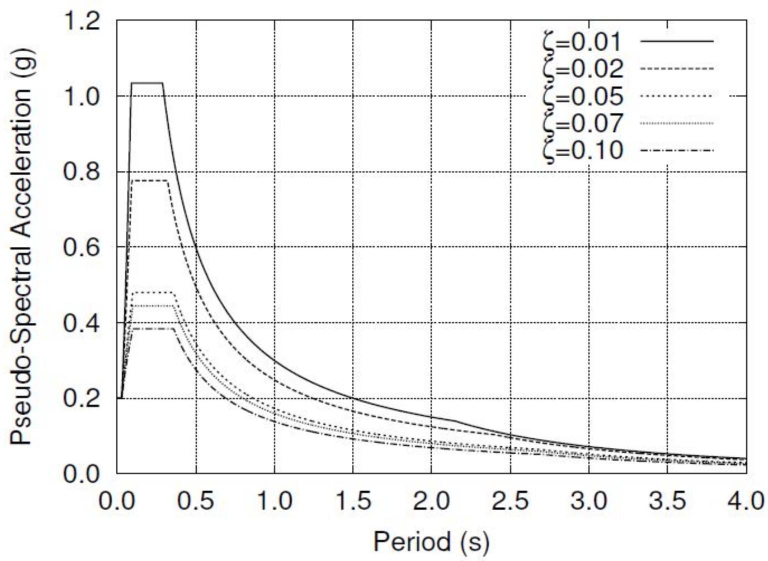
Spectra for DBE motion (Gongri HEP)

Ratle HEP The estimated seismic coefficients are: $\alpha_h = 0.15$ and $\alpha_v = 0.10$



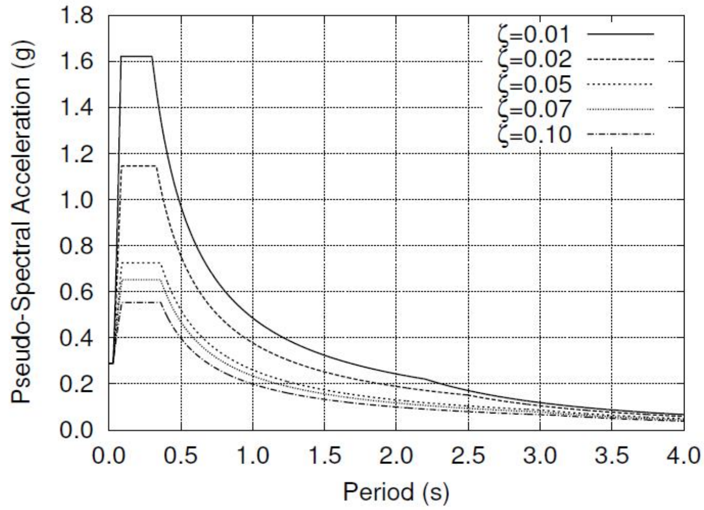
Spectra for DBE motion (Ratle HEP)

Rangit-II HEP The estimated seismic coefficients are: $\alpha_h = 0.13$ and $\alpha_v = 0.09$



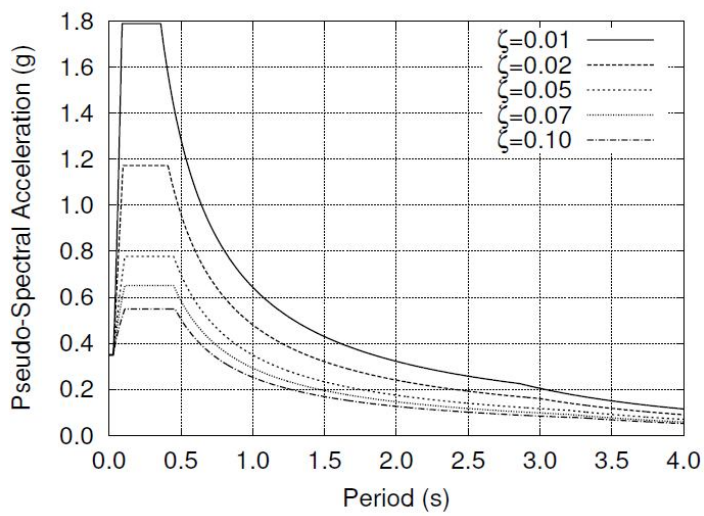
Spectra for DBE motion (Rangit-II HEP)

Thana Plaun HEP The estimated seismic coefficients are: $\alpha_h = 0.19$ and $\alpha_v = 0.13$



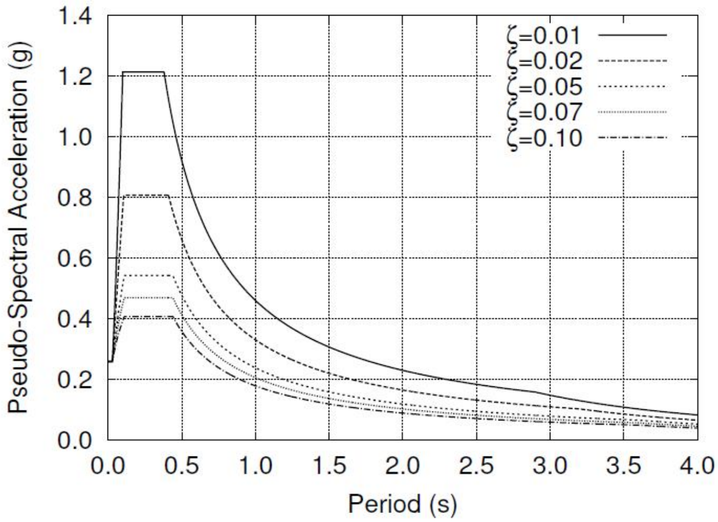
Spectra for DBE motion (Thana Plaun HEP)

Shongtong Karcham HEP The estimated seismic coefficients are: $\alpha_h = 0.21$ and $\alpha_v = 0.14$



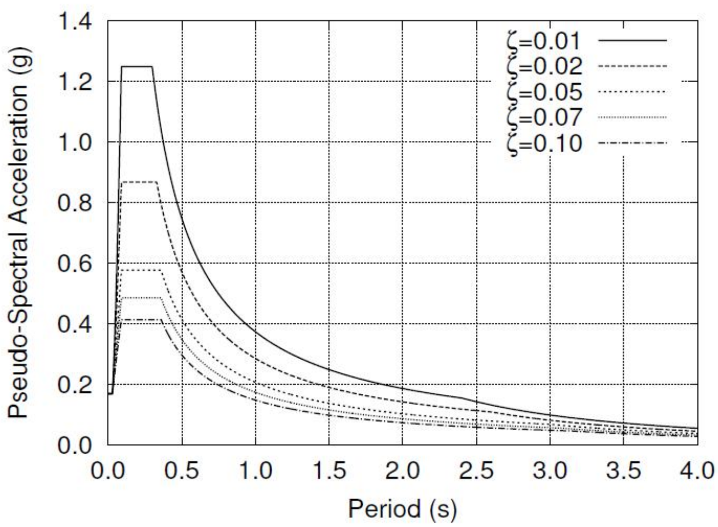
Spectra for DBE motion (Shongtong Karcham HEP)

Miyar HEP The estimated seismic coefficients are: $\alpha_h = 0.14$ and $\alpha_v = 0.10$



Spectra for DBE motion (Miyar HEP)

Nyukcharong HEP The estimated seismic coefficients are: $\alpha_h = 0.15$ and $\alpha_v = 0.10$



Spectra for DBE motion (Nyukcharong HEP)

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Government of India
जल संसाधन मंत्रालय
Ministry of Water Resources
केन्द्रीय जल और विद्युत अनुसंधान शाला
Central Water & Power Research Station
खडकवासला पुणे-411024, भारत
Khadakwasla, Pune – 411 024

Tel : 020-24103396, 24103356
Fax: 020-24381004
E-mail: wapis@cwprs.gov.in
lrpattanur@yahoo.co.in
Web Site: www.cwprs.gov.in

No. 322/193/VT/2007 Dated:07.08.2013

Shri O.P.Gupta,
CWC, New Delhi

Sub: Estimation of site-specific seismic parameters of Halon Project, M.P.

Sir,

Please find attached the details of the seismic coefficients for Halon project

Thanking you,

Yours faithfully

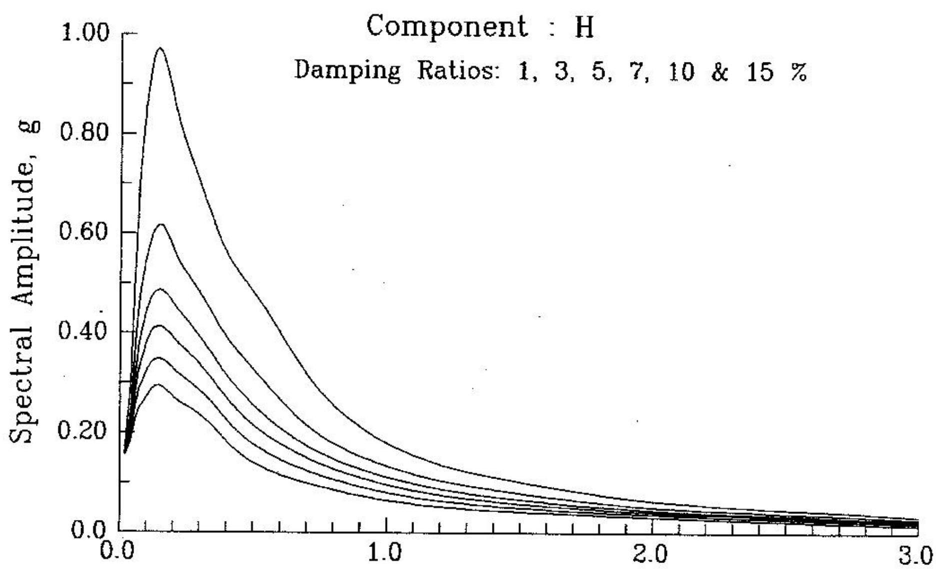
(L.R. Pattanur)
Senior Research Officer

E:\PROJECTS\halon\seismic coeff-covlet-06.08.2013.DOC

ESTIMATION OF SITE-SPECIFIC DESIGN SEISMIC GROUND MOTION FOR HALON PROJECT, MADHYA PRADESH

Technical Report No.4555 provides the MCE level of design spectra for damping ratios 1,3,5,7,10,15% for horizontal and vertical ground motions. In the report it is recommended that the DBE level of design spectra be taken as one half of the MCE level of spectra. The horizontal seismic coefficient is taken as 1/3.75 of the spectral acceleration at the period 0.2 sec of the DBE level design spectrum with damping ratio of 10% for earthen dam and 5% for concrete/masonry dams.

For the earthen dam portion of the Halon dam, using the 10% damped horizontal design spectrum the horizontal seismic coefficient (α_h) works out to be 0.04 and the vertical seismic coefficient (α_v) taken as 2/3rds of α_h is found to be 0.03. Similarly, for the concrete spillway section, using the 5% damped horizontal design spectrum the horizontal seismic coefficient (α_h) works out to be 0.06 and the vertical seismic coefficient (α_v) taken as 2/3rds of α_h is found to be 0.04. The design spectra for horizontal component of ground motion are plotted below.



MCE level of the smoothed design response spectra with damping ratios of 1, 3, 5, 7, 10 and 15% for horizontal component of ground motion

भारत सरकार
Government of India
जल संसाधन मंत्रालय
Ministry of Water Resources
केन्द्रीय जल और विद्युत अनुसंधान शाला
Central Water & Power Research Station
खडकवासला पुणे-411024, भारत
Khadakwasla, Pune – 411 024

अनुसंधान के माध्यम से सेवा
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Tel : 020-24103396, 24103356
Fax: 020-24381004
E-mail: wapis@cwprs.gov.in
lrpattanur@yahoo.co.in
Web Site: www.cwprs.gov.in

No. 322/193/VT/2007

Dated:14.08.2013

Shri O.P.Gupta,
CWC, New Delhi

Sub: Estimation of site-specific seismic parameters of Halon Project, M.P.

Sir,

The strong motion duration is 6.83 sec and total duration is 40.0 sec for horizontal and vertical components of MCE and DBE levels of ground motion for the subject project.

Thanking you,

Yours faithfully

(L.R. Pattanur)
Senior Research Officer

Office of the Executive Engineer
Narmada Development Halon Division
Bichhiya Distt. Mandla

Memo No. 466 /TS/2013 Bichhiya Dated : 12/06/2013

To,

The Deputy Director
F.E.& S.A. Directorate
Central Water Commission
712 (S) Sewa Bhawan, R.K.Puram.
New Delhi – 110066

Sub: **Site specific Design Earthquake parameters for Halon Project, Madhya Pradesh- reg.**

Ref : (1) Your Office no.2/2/2013(Vol-1/FE&SA/309 Dtd. 14.05.2013.

With reference to letter cited above, kindly find enclosed hsrewith tke information received from Central Water and power research station Khadakwasla, Pune vide their letter no, 322/193/VT/2007 dated 10.06.2013 as saught by your office please.

Encl :-- as above.

Executive Engineer
Narmada Development Halon Division
Bichhiya Distt. Mandla

Endt. No. 902-A /TS/2012 Bichhiya Dated : **/06/2013**

Copy is forwarded to :-

1. The Chief Engineer, R.A.B.L.S.Projects, Bargi Hills, Jabalpur
2. The Superintending Engineer, R.A.B.L.S.(Canal Cell), Bargi Hills, Jabalpur For information please.

Sd -
Executive Engineer
Narmada Development Halon Division
Bichhiya Distt. Mandla

भारत सरकार
Government of India
जल संसाधन मंत्रालय
Ministry of Water Resources
केन्द्रीय जल और विद्युत अनुसंधान शाला
Central Water & Power Research Station
खडकवासला पुणे-411024, भारत
Khadakwasla, Pune – 411 024

अनुसंधान के माध्यम से सेवा
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Tel : 020-24103396, 2410335
Fax: 020-24381004
E-mail: wapis@cwprs.gov.in
lrpattanur@yahoo.co.
Web Site: www.cwprs.gov.in

No. 322/193/VT/2007

Dated: 10.06.2013

Executive Engineer
Narmada Development Halon Division
Bichhiya, Mandla (Dist.)
Madhya Pradesh

Sub: Estimation of site-specific seismic parameters of Halon Project, M.P.

Ref: Your Memo No.443/SAC/1 DL 2012-13 dated 05.06.2013

Sir,

With reference to your above mentioned letter, the values of horizontal (A_h) and vertical (A_v) seismic coefficients for 35.5 m high tallest spillway section are found to be α_h = 0.104 and α_v = 0.069, respectively, assuming the unit weight (w_c) for concrete of the spillway as 2400 kg/m^3 and the modulus of elasticity (E_s) as 2.0×10^9 kg/m^2

Thanking you,

Yours faithfully

(L.R. Pattanur)
Senior Research Officer

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Annexure-VI

Government of India
Ministry of Water Resources
(State Projects Wing)

....

Shram Shakti Bhawan,
Rafi Marg, New Delhi-110001
Dated the 3rd June, 2013

To
Dr. B.R.K. Pillai,
Director (FE&SA) & Member Secretary, NCSDP
Central Water Commission,
712(S), Sewa Bhawan,
R K Puram, New Delhi-66

Sub: Composition and Terms of reference of National committee on Seismic Design Parameters (NCSDP) - suggestions/ recommendations reg.

Please refer to your letter dated 10.5.2013, on the subject mentioned above. In this regard, the comments of SPR Wing may please be treated as NIL.

(Pradeep Kumar)
Commissioner(SP)
Tel. 23710107
Fax: 23350051

Annexure-VII

भारतीय सर्वेक्षण विभाग
SURVEY OF INDIA

तार सरसर्च
Telegram : "SURSEARCH"
फ़ैक्स व दूरभाष : 0091-0135-2654528
Fax-cum-Telephone : 0091-0135-2654528
ई–मेल E-Mail : grb_soi@redeffmail.com

ज्योडीय एवं अनुसंधान शाखा
GEODETIC & RESEARCH BRANCH
7ई0 सी0 रोड,पत्र पेटी सं0 77
17-E.C. ROAD, P.B. NO. 77
देहरादून– 248001
DEHRA DUN – 248 001

No. T- 1685 /14 –C (S & ST)

Dated: 26 June, 2013

To.

Dr. B. R. K. Pillai
Director
(FE & SA Dte) & Member Secretary NCSDP
Central Water Commission
F. E & S. A, Directorate
712 (S), Sewa Bhawan, R. K. Puram
New Delhi-110066
Tel/Fax-011-26101017
e-mail-fesadte-cwc@nic.in

SUB:- COMPOSITION AND TERMS OF REFERENCE (TOR) OF NATIONAL COMMITTEE ON SEISMIC DESIGN PAMETTERS (NCSDP)-SUGGESTIONS/ RECOMMENDATIONS-REG.

REF:- (i) Your letter No. 02/02/2013 (Vol. I) /FE &SA/ 305 dated 10-05-2013.
(ii) Your letter No. 02/02/2013 (Vol. I) /FE &SA/ 247 dated 16-04-2013.

******

Sir,

With reference to the above, as far as composition of committee is concerned, we feel that composition of committee is quite comprehensive and we do not suggest any change.

2. In the report of four projects submitted vide reference (ii), 'g' from Coefficient α_h & α_v should be removed.
3. 'g' from Coefficient α_h & α_v should be removed from five project reports submitted vide letter No.02/02/2013 (Vol. I) /FE &SA/ 370 dated 30-05-2013.
4. From the reports, it is not understood whether earthquake safety evaluation of dam has been done for normal full load of water level. If not, it should be taken care of.

(U. N. MISHRA)
Director,
Geodetic & Research Branch

Date: 26-06-2012 **Annexure-VIII**

From
Niroj Kumar Sarkar
Superintending Geologist
LHZ Project
Geological Survey of India
North Eastern Region,
Shylla Building, Nongrim Hill
Shillong- 793 003
Email: n.sarkar@gsi.gov.in :
niroj4@gmail.com

To
To
The Director(FEA&SA) & Member
Secretary(NCSDP),
Central Water Commission.
712(S), Sewa Bhawan, R.K.Puram
New Delhi- 110016
FAX: 011-26101017
E mail: fesadte-cwc@nic.in

Sub: Comments on the Composition and Terms of References (ToR) of NCSDP

Ref: letter no 2/2/2013(vol-I)/FE&SA/302 dated 10-05-2013 form Member secretary, NCSDP

Sir

In reference to your correspondences cited above, please find enclosed the required comments on the composition and Terms of References (ToR) of NCSDP. The same is done after critical examination of the existing composition and terms of references of the NCSDP (order No 29/1798-P.I dated 11-02-2004 of Ministry of Water Resources) which was forwarded to the GSI.

I. **Comments in respect to the composition of the committee**

i. Besides the Director General, GSI (or his nominee), Director, Engineering Project Evaluation, DGCO, GSI, New Delhi may be nominated as a member of the NCSDP since geological and tectonic aspects of the DPR for major River valley projects are being evaluated through his office.

ii. The dual role of both consultant to the project and at the same time as a member of the NCSDP for reviewing of the same project in respect of some of the organisations/members need to be reviewed.

iii. Further, the number of authenticated member be strictly adhered to

iv. The authorised member from each organisation/department may be authenticated annually from the respective organisation/department.

II. **Comments in respect to the Terms of References of the Committee**

Since a guideline for preparation and submission of site specific seismic study report for river valley projects has already been published by the secretariat of NCSDP, the suggested terms of references therefore may be

i) Examination of the submitted site specific seismic study report in terms of their compliance to the guidelines.

ii) Evaluation of the study results considering all aspects of the site and the terrain

iii) If required, suggestions for further studies in some aspects for total compliances of the guideline and improvement of the study report.

iv) Periodic review of the guidelines in view of the emerging scenario worldwide in respect to the techniques and methodologies for seismic hazard assessment

This has the approval of the competent authority

Yours faithfully

Niroj Kumar Sarkar
Superintending Geologist

Copy forwarded for kind information to:

1. Dy. Director General, Mission-IV A, GSI, CHQ, Kolkata. This is as per the discussion the undersigned had with him on the subject.
2. Dy. Director General & HOD, GSI, NER, Shillong