

Annual Report

Department of Earthquake Engineering

2019-2020



Indian Institute of Technology Roorkee

Roorkee, Uttarakhand

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Academic Staff: 13, Students Admitted: M.Tech: 35; Ph.D: 12,
Publications in: Journals: 29, Conferences: 19, Book: NIL,
Projects: Research (Rs. in Lacs): 622.47 , Consultancy (Rs. in Lacs): 1172.79

1. Salient Features

a. Introduction

The Department of Earthquake Engineering at the Indian Institute of Technology Roorkee (erstwhile University of Roorkee) was established in 1960 as School of Research and Training in Earthquake Engineering. Four major areas of earthquake engineering viz., Structural Dynamics, Soil Dynamics, Engineering Seismology and Seismotectonics, and Instrumentation have been nurtured for the last fifty years. The department provides Master's degree in three specializations namely, Structural Dynamics, Soil Dynamics, and Seismic Vulnerability and Risk Assessment. The major functions of the Department include teaching and research, and rendering expert advice to various organizations in the area of earthquake resistant design of structures and systems, such as dams, bridges, power plants, etc. The Department has played a key role at the national level in the formulation of Indian Standard Codes of Practice for earthquake resistant design of Structures.

Several major facilities have been developed in the Department to conduct experiments related to earthquake engineering. Some of the major facilities include: recently commissioned full scale pseudo-dynamic structural test facility having 8 m tall reaction walls, a low cost shock table on railway wagons, for dynamic testing of structural models, a computer controlled shake table to stimulate strong ground motion, a quasi-static testing laboratory having servocontrolled dynamic actuator systems and servo-controlled compression testing machine, a soil dynamics laboratory equipped with liquefaction table, cyclic triaxial testing system, and resonant column apparatus, a seismological observatory having state of the art broadband seismograph to record earthquake ground motion, a strong motion network of 300 digital accelerographs deployed in the Himalayan region to measure strong ground motion due to moderate and major earthquakes and a state-of-the-art 12-station telemetered network to monitor local seismicity in the environs of Tehri Dam.

b. Academic Programs

The Department of Earthquake Engineering offers postgraduate M.Tech. (admission through GATE/sponsorships) and Ph.D. (through selections/ sponsorships) programs in following three specializations:

- *Soil Dynamics*
- *Structural Dynamics*
- *Seismic Vulnerability and Risk Assessment.*

During 2019-20, 31 M.Tech. degrees and 09 Ph.D. degrees were awarded from the Department.

2. List of Faculty Members**a. Professors**

- i. B. K. Maheshwari
- ii. J. P. Narayan
- iii. Pankaj Agrawal
- iv. Manish Shrikhande
- v. M. L. Sharma
- vi. Yogendra Singh

b. Associate Professors

- i. D. Shanker
- ii. Josodhir Das
- iii. R. N. Dubey
- iv. Ravi S. Jakka
- v. S. C. Gupta

c. Assistant Professors

- i. P. C. Ashwin Kumar
- ii. Saurabh Shiradhonkar

3. Honours and Awards to Faculty Members

a. B. K. Maheshwari

- Awarded “Shamsher Prakash Professorial Chair” for 3 years since August 2019.
- Unanimously elected Vice President of Indian Society of Earthquake Technology for 2 years since April 2019.

b. Ravi S. Jakka

- Ravi Jakka has been appointed as a NCS-MoES expert committee member for the seismic microzonation studies in India.
- Unanimously elected as Secretary of Indian Society of Earthquake Technology (ISET) for the term 2019-2021 (2 years).

4. Participation of faculty in Conferences /Seminar /Symposia /Workshop / Guest Lectures (National & International).

| National | | | |
|--------------------|---|----------------|----------------------|
| Name of Faculty | Detail of Conf./Semi/Symp./Workshop/Guest Lecture | Venue | Date |
| B. K. Maheshwari | Indian Geotechnical Conference (Attended and delivered theme lecture on “Recent Advances in Liquefaction”.) | Surat | December 2019 |
| B. K. Maheshwari | Delivered 2 invited guest lectures at IISc Bangalore under DRIP program | Bangalore | August 2019 |
| Ravi S. Jakka | Participated and presented technical papers at Indian Geotechnical Conference | Surat, Gujarat | December 19-21, 2019 |
| Ravi S. Jakka | Delivered an invited lecture delivered at a 2Day National Workshop on “Recent Trends in Geotechnical Engineering” | NIT Trichy | June 7-8, 2019 |
| Ravi S. Jakka | Guest Lecture delivered on “Role of Geotechnical Engineering in Seismic Design of Structures” | IIT Guwahati | February 25, 2020 |
| P. C. Ashwin Kumar | National Welding Meet 2019 | Delhi | August 2-3, 2019 |
| P. C. Ashwin Kumar | Delivered lectures during GIAN course on ‘Seismic Design of Steel Structures’ | IIT Delhi | October 21-25, 2019 |

| | | | |
|--------------------------------------|---|---------|---------------------|
| P. C. Ashwin Kumar Pankaj Agarwal | The Workshop on Enabling Procedures for Increase of Steel usage for the Growth of Economy | Delhi | February 24, 2020 |
| P. C. Ashwin Kumar | IndiaWelds Synergy 2019: Creating Sustainable Welding Excellence through Industry – Academia Synergy! | Delhi | November 21, 2019 |
| P. C. Ashwin Kumar | Delivered a lecture during ‘Training Program on Refresher Course on Building Design and Construction for the Engineers of Tata Steel’ | Roorkee | January 16-18, 2020 |

| International | | | |
|------------------------|--|--------------------------------------|---------------------------|
| Name of Faculty | Detail of Conf./Semi/Symp. /Workshop/Guest Lecture | Venue | Date |
| P. C. Ashwin Kumar | The 12th Pacific Structural Steel Conference | Tokyo Institute of Technology, Tokyo | November 09-11, 2019 |
| Daya Shanker | CTBTO Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization SnT2019 conference | Vienna, Austria | June 24-28, 2019 |
| Daya Shanker | The XXVII IUGG General Assembly of IUGG2019 | Montreal, Canada | July 08-18 2019. |
| Daya Shanker | 11th International workshop on Statistical Seismology (StatSei11-2019) | Tichikawa Tokyo, Japan, | July 18 - August 21, 2019 |
| Daya Shanker | Workshop on slow Earthquake 2018 from | Sendai, Japan | September 21-23, 2019 |
| Daya Shanker | International Conference on Earth and Environmental Sciences & Technology for Sustainable Development, | University of Dhaka, Bangladesh | January 25-30, 2020. |
| S. C. Gupta | 2nd Conference of Arabian Journal of Geosciences | Sousse, Tunisia | November 25-28, 2019 |

5. Total Number of Faculty Members Participated in Short Term Courses.

| | |
|----------------------|-----|
| National | 06 |
| International | NIL |

6. Distinguished Visitors to The Department (National/International)

| National | | | |
|--------------------|--|---|-------------------|
| Name | Designation and Affiliation | Purpose | Dates |
| Er. Subodh K. Jain | Member Engineering (Retd.) Railway Board | To deliver lecture in ITR-RDSO 3-day International Course on Recent Advances in Bridge Design and Construction. | August 7-9, 2019 |
| Dr. Anurag Kumar | Director, IISc Bangalore | To visit the Shock Table, Shake Table, Foundation Lab, Pseudo-Dynamic Structural test facility & Seismological Observatory in the Department of Earthquake Engineering, IIT Roorkee | November 09, 2019 |
| Dr. Vinay K. Gupta | Professor, Civil Engineering, IIT Kanpur | To delivered a lecture in 1-Day Worksop on “Strong Motion Studies and Selection of Ground Motion For Non-Liner Time History Analysis” | December 16, 2019 |

| | | | |
|-------------------------------|---|--|-----------------------|
| Er. Jatan Swarup Sharma | Additional Director General (Border), CPWD, Ministry of Housing and Urban Affairs, Govt. of India | To delivered a professional talk on Structural and Geotechnical Challenges at the Border Areas in India. | January 24, 2020 |
| International | | | |
| Name | Designation and Affiliation | Purpose | Dates |
| Dr. Oreste Salvatore BURSI | Professor, Department of Civil, Env. & Mechanical Engineering, University of Trento, Italy | To conduct GIAN Course on Probabilistic Analysis of Power Plants and Design of Metamaterial-based Shields for Enhanced Performance | April 22- 26, 2019 |
| Dr. Svetlana Brzev | Adjunct Professor, University of British Columbia, Vancouver, Canada | To delivered a lecture on "Earthquake Resistant Design of Masonry Building- The State of Art". | May 9, 2019 |
| Dr. Dominik Lang | Director, Natural Hazards, NGI, Norway | To deliver lecture in ITR-RDSO 3-day International Course on Recent Advances in Bridge Design and Construction. | August 7- 9, 2019 |

| | | | |
|-----------------------|---|---|----------------------|
| Dr. Amir M. Kaynia | Professor, NTNU, Norway and Technical Expert, NGI, Norway | To deliver lecture in ITR-RDSO 3-day International Course on Recent Advances in Bridge Design and Construction. | August 7-9, 2019 |
| Dr. Satwant S. Rihal | Professor, CAED, Cal Poly, San Luis Obispo | To visit the Pseudo-Dynamic Structural test facility in the Department of Earthquake Engineering, IIT Roorkee | August 08, 2019 |
| Dr. Graham Brewer | Professor, School of Architecture and Built Environment University of Newcastle, Australia | To Lecture on “Contemporary UN agendas: an Australian perspective” | November 11, 2019 |
| Dr. Mihailo Trifunac | Professor, Civil & Environmental Engineering Department, University of Southern California Los Angeles, USA | To delivered inaugural lecture of ‘Hudson Memorial Lecture Series’ entitled "D.E. Hudson: An Opus in Experimental Earthquake Engineering" | December 16, 2019 |
| Dr. Mahendra P. Singh | Preston Wade Professor emeritus in Virginia Tech | To delivered a lecture in 5-day short term course on 'Risk Targeted Seismic Design' | February 18-22, 2020 |

7(a). Internships By IIT-Roorkee Students

| Sl. No. | Name of Student | Name of Internship Programme | Under Graduate | Post Graduate | Name of Institute Visited | Period |
|---------|-----------------|------------------------------|----------------|---------------|---------------------------|--------|
| | | | | | | |

7(b). Internships Offered to Other Students in IIT-Roorkee

| Sl. No. | Name of Student | Name of Internship Programme | Under Graduate | Post Graduate | Name of Institute Visited | Period |
|---------|-----------------|------------------------------|----------------|---------------|---------------------------|--------|
| | | | | | | |

8. Academic Activities Organized by the Department

| Name of Conf./Seminar/Symp./Workshop | Name of the Chairman | Sponsored by | Dates |
|---|---|--------------------------------|--------------------------------|
| 2-Day Short Term course | Ravi Jakka (Coordinator) | DRIP, CWC | June 17-18, 2019 |
| 3-Day Short Term course | Ravi Jakka (Coordinator) | DRIP, CWC | June 19-21, 2019 |
| 3-Day International course on "Recent Advances in Bridge Design and Construction". | Yogendra Singh & P.C. Ashwin Kumar (Coordinators) | RDSO, Indian Railways | August 07-09, 2019 |
| “Seismic Design and Safety Evaluation of Concrete Gravity Dams, Training Program | Pankaj Agarwal & Manish Shrikhande (Coordinators) | DRIP, CWC | September 11-14, 2019 |
| 1-Day Worksop on “Strong Motion Studies and Selection of Ground Motion For Non-Linear Time History Analysis” | Saurabh Siradhonkar & Yogendra Singh (Coordinators) | DEQ, IIT Roorkee | December 16, 2019 |
| 5-day short term course on 'Risk Targeted Seismic Design' | Saurabh Siradhonkar & Yogendra Singh (Coordinators) | Self- Supported Activity | February 18-22, 2020 |
| GIAN Course: Probabilistic Analysis of Power Plants and Design of Metamaterial-based Shields for Enhanced Performance | Anil Kumar (MIED) & Yogendra Singh (Coordinators) | MHRD GoI | April 22- April 26, 2019 |
| QIP Course: Vibration Mitigation Systems – Analysis and Design | Anil Kumar (MIED) & Yogendra Singh (Coordinators) | AICTE | May 27-31, 2019. |

9. Sponsored Research Projects

| Sl. No. | Project Status | Total No. of Projects | Amount (Rs. In Lacs) |
|---------|-------------------|-----------------------|----------------------|
| 1. | Complete Projects | 02 | 329.20 |
| 2. | Ongoing Projects | 09 | 293.27 |
| 3. | New Projects | 05 | 149.54 |

10. Service to Industries

a. Consultancy Projects

| Sl. No. | Project Status | Total No. of Projects | Amount (Rs. In Lacs) |
|---------|-------------------|-----------------------|----------------------|
| 1. | Complete Projects | 17 | 493.70 |
| 2. | Ongoing Projects | 50 | 679.09 |
| 3. | New Projects | 50 | 679.09 |

b. Testing Services

| Sl. No. | No. of Industries Served | Total Outlay (Rs. In Lacs) |
|---------|--------------------------|----------------------------|
| 1. | 01 | 5.0 |

11. Summary of Major Sponsored Research Schemes and Consultancy Projects (Rs. 20 lacs) (a brief write-up upto 100 words) (new projects during the year).

a. Foundation Engineering Laboratory

Foundation Engineering Laboratory at the Department of Earthquake Engineering, IIT Roorkee, is newly revived with the funding received under DRIP. It is now equipped to carry out advanced research/consultancy services in the area of Embankment Dam engineering. All the geotechnical engineering properties of the dam and foundation materials required for determining dynamic response and seismic stability of the dam, can be determined in this Foundation Engineering Laboratory. This Laboratory consists of Large Size Cyclic Tri-axial, Servo-hydraulic Shaking Table, Bender Element, Model Testing Tank with loading frame, Laminar Box, and other testing equipment.



Picture.1 - Large Size Cyclic Triaxial Machine & Servo Controlled Uni-axial Hydraulic Shake Table at Foundation Engineering Laboratory, Dept. of Earthquake Engg.

b. Seismological and Strong motion network around Tehri dam, Uttarakhand

A 18-station seismological network around Tehri dam and a 13-station strong motion network in dam body, power house and Koteshwar dam body is in operation in the Garhwal Himalaya, Uttarakhand. The network is continuous operation since July 1995. Tehri dam is highest dam rock fill dam in country with 260.6 meters height that falls in seismic zone IV as per the seismic zoning map of India. The study is being carried out on three years' basis under a MoU between the Department of Earthquake Engineering, IIT Roorkee and Tehri Hydro Development Corporation India Ltd. (THDCIL), Rishikesh for the purpose of

monitoring of local earthquake activity around Tehri dam and recording of strong ground motion of any small to moderate and large earthquake in case of such earthquake occur in the region around dam site. The current MoU for three years is started from October 25, 2019.

12. Scientific and Technical Reports

| Title of the Projects | Participants | Authors | Remarks |
|--|--|--|--|
| Nonlinear Dynamic Analysis of A Turbo-Generator Foundation | P.C. Ashwin Kumar, Yogendra Singh and B.K.Maheshwari | P.C. Ashwin Kumar, Yogendra Singh and B.K.Maheshwari | Study was sponsored by NTPC |
| Seismic Analysis of Luhri Dam(HEP) Stage-1, Himachal Pradesh | Yogendra Singh, Ravi Jakka, and P.C. Ashwin Kumar | Yogendra Singh, Ravi Jakka, and P.C. Ashwin Kumar | Satluj Jal Vidyut Nigam Limited (SJVNL), Shimla |
| Geotechnical Seismic Study for co-ordinates 24 ⁰ 3'11.53''N / 69 ⁰ 37'37.36''E site of Wind farm of Renewable Project Site at Bhuj | B.K.Maheshwari | B.K.Maheshwari | Adani Green Energy Ltd., Ahmedabad |
| Microearthquake studies around Thana Plaun HE Project, Himachal Pradesh. Report on processing and interpretation of Seismological Data collected from October 2018 to April 2019 | S.C. Gupta, M.L. Sharma, J. Das, A.K. Jindal, A. Sen and S.K. Jain | S.C. Gupta, M.L. Sharma, J. Das, A.K. Jindal, A. Sen and S.K. Jain | Technical report (EQ: 2019-16) submitted to HPPCL, Shimla (2019). |
| Strong Motion Network around Tehri Region, Report on processing and interpretation of strong motion data collected from January to December 2018 | M.L. Sharma, S.C. Gupta, R. Sachdeva, and A.K. Jindal | M.L. Sharma, S.C. Gupta, R. Sachdeva, and A.K. Jindal | Technical report (EQ: 2020-05) submitted to THDCIL, Rishikesh (2020) |

| | | | |
|--|--|--|---|
| Seismological Network around Tehri Region, Report on processing and interpretation of seismological data collected from January to December 2018 | M.L. Sharma, S.C. Gupta, J.P. Narayan, J. Das, A.K. Jindal, S.K. Jain and A. Sen | M.L. Sharma, S.C. Gupta, J.P. Narayan, J. Das, A.K. Jindal, S.K. Jain and A. Sen | Technical report (EQ: 2019-23) submitted to THDCIL, Rishikesh (2020). |
| Preliminary Seismological and Strong Ground Motion Bulletin from October to December 2018 | M.L. Sharma, S.C. Gupta, J.P. Narayan, A.K. Jindal, S.K. Jain and A. Sen | M.L. Sharma, S.C. Gupta, J.P. Narayan, A.K. Jindal, S.K. Jain and A. Sen | Bulletin (EQ: 2019-15) submitted to THDCIL, Rishikesh (2019). |
| Preliminary Seismological and Strong ground motion Bulletin from January to March 2019 | M.L. Sharma, S.C. Gupta, J.P. Narayan, A.K. Jindal, S.K. Jain and A. Sen | M.L. Sharma, S.C. Gupta, J.P. Narayan, A.K. Jindal, S.K. Jain and A. Sen | Bulletin (EQ: 2019-18) submitted to THDCIL, Rishikesh (2019). |
| Preliminary Seismological and Strong ground motion Bulletin from April to June 2019 | M.L. Sharma, S.C. Gupta, J.P. Narayan, A.K. Jindal, S.K. Jain and A. Sen | M.L. Sharma, S.C. Gupta, J.P. Narayan, A.K. Jindal, S.K. Jain and A. Sen | Bulletin (EQ: 2019-21) submitted to THDCIL, Rishikesh (2019) |
| Preliminary Seismological and Strong ground motion Bulletin from July to September 2019 | M.L. Sharma, S.C. Gupta, J.P. Narayan, A.K. Jindal, S.K. Jain and A. Sen | M.L. Sharma, S.C. Gupta, J.P. Narayan, A.K. Jindal, S.K. Jain and A. Sen | Bulletin (EQ: 2019-24) submitted to THDCIL, Rishikesh (2020) |
| Preliminary Seismological and Strong ground motion Bulletin from October to December 2019 | M.L. Sharma, S.C. Gupta, J.P. Narayan, A.K. Jindal, S.K. Jain and A. Sen | M.L. Sharma, S.C. Gupta, J.P. Narayan, A.K. Jindal, S.K. Jain and A. Sen | Bulletin (EQ: 2020-04) submitted to THDCIL, Rishikesh (2020) |

13. Research Publication

| Sl. No. | Details | Total Number |
|---------|---------------------------|--------------|
| a. | Conference/Symp./Seminars | 06 |
| b. | International Conference | 13 |
| c. | National Journals | 04 |
| d. | International Journals | 25 |

Research Publication during the year under report (To be listed on the basis of first author only, as given below). **Separate group for Conference/Symp./Papers and Books/Monographs be made.**

a. Conference/ Symp./ Seminars

- i. Maheshwari, B.K., "Recent Advances in Liquefaction of Soils" Theme Lecture, Proc. of the Indian Geotechnical Conference, Surat, December 2019.
- ii. Das, S. and Maheshwari, B. K., "Stability Analysis of Soil Slopes Subjected to Foundation Loads during Earthquakes", Proc. of the Indian Geotechnical Conference, Surat, Dec. 2019.
- iii. Desai, A., and Jakka, R. S., "Effect of A-priori Information on the Uncertainties in MASW Test", Indian Geotechnical Conference on Geotechnics for Infrastructure Development & Urbanization, Surat, India, December 19 - 21, 2019.
- iv. Kranthikumar, A. and Jakka, R. S., "Behavior of Large Diameter Pile Resting on Sloping Ground", Indian Geotechnical Conference on Geotechnics for Infrastructure Development & Urbanization, Surat, India, December 19 - 21, 2019.
- v. Mugesh, A., Desai, A., Jakka, R. S., and Kamal., "Study of Local Site Effects on Earthquake Early Warning", Indian Geotechnical Conference on Geotechnics

for Infrastructure Development & Urbanization, Surat, India, December 19 - 21, 2019.

- vi. Nautiyal, P., Raj, D., Bharathi, M. and Dubey, R.N., (2019). “Ground Response Analysis: Comparison of 1D, 2D and 3D Approach”, Indian Geotechnical Conference, SVNIT Surat, India, December 19 - 21, 2019.

b. International Conference

- i. Desai, A., Roy, N. Jakka, R.S., Narayan, J.P. & Kranthikumar, A., “Influence of source characteristics on the uncertainties in MASW survey”, **Proceedings 7th International Conference on Earthquake Geotechnical Engineering (VII ICEGE), Rome, Italy, Vol. 4, pp. 2068-2075, June 17-20, 2019.**
- ii. Nambirajan, T., Mushtaq, Z. and Kumar, P. C. A., “Comparative evaluation of design methodologies for eccentrically braced steel frames with short links”, **Proceedings of 12th Pacific Structural Steel Conference, Tokyo, Japan, Novemeber 9-11, 2019.**
- iii. D. Shanker and Shubham (2019). Seismic Hazard Scenario In Western Himalaya, India; CTBTO, **SnT2019 conference in Vienna, Austria, from 24 to 28 June 2019; T1.2-P63; page 40**
- iv. D. Shanker and Tinku Biawas (2019). Characterization of Seismic Source Potentials and evaluation of earthquake Hazard – A Deterministic Approach; **XXVII IUGG General Assembly of IUGG2019 in Montreal, Canada (8-18 July 2019).**
- v. D. Shanker and Bhawani Singh (2019). Trending Discussion on Earthquake Control – A Novel Idea of Understanding and Managing Earthquake Risks in the Himalaya; **XXVII IUGG General Assembly of IUGG2019 in Montreal, Canada (8-18 July 2019).**
- vi. D. Shanker (2019). Triggering Effect of Uttarkashi Earthquake of October, 1991 (M6.6) was the Real Source for the Two Swarms (1995&1996) in Garhwal Himalayas; **XXVII IUGG General Assembly of IUGG2019 in Montreal, Canada (8-18 July 2019).**

- vii. D. Shanker and H. Paudyal (2019). Development of predictive equations for earthquake forecast in south central Tibet region of Himalaya, **11th International workshop on Statistical Seismology (StatSei11-2019) Japan, Tokyo Hakone; Institute of Statistical Mathematics Tichikawa Tokyo 18 July - 21 August, 2019.**
- viii. D. Shanker, Shubham and Komal Soni (2019). Probabilistic Seismic Hazard Analysis (PSHA) for State of Uttarakhand Himalaya India, **Workshop on slow Earthquake 2018. Sendai, Japan from 21-23 September, 2019.**
- ix. D. Shanker and Shubham (2020). Seismic hazard in terms of Peak Ground Acceleration (PGA) for state of Uttarakhand, Himalaya; **International Conference on Earth and Environmental Sciences & Technology for Sustainable Development, January 25-30, 2020, University of Dhaka, Bangladesh, ICDRS-O-011 .**
- x. Gwalani, P., Singh, Y., and Varum, H. (2019). Comparative Seismic Fragility of Torsionally Irregular RCC Buildings Designed Using Indian and European Codes, Proceedings of SECED – **An International Conference on Earthquake Risk and Engineering towards a Resilient World, September 2019, Greenwich, London.**
- xi. Goswami N., Gupta, S.C., Kumar, A. and Sharma, M.L., Source and path characteristics of Chamoli region, India, **2nd Conference of the Arabian Journal of Geosciences, Sousse, Tunisia, Nov. 25-28, 2019, Paper 262.** (Accepted for publication).
- xii. Kumari, N. and Sharma, M.L. (2019). Empirical relation of cumulative absolute velocity for Western Himalaya, **Int. Conf. in Commemoration of 20th Ann of the 1999 Chi-Chi Earthquake Taipei, Sept 15-19, 2019.**
- xiii. Bajaj, S. and Sharma, M.L. (2019). Time dependent Probablitic Seismic Hazard Assessment for Himalayan region, **Int. Conf. in Commemoration of 20th Ann of the 1999 Chi-Chi Earthquake Taipei, Sept 15-19, 2019**

c. National Journals

- i. Soni, K., Shanker, D., Shubham and Sabah, N. (2019). “Estimation of Seismic Hazard Parameters for Uttarakhand Region”, **Journal of Rock Mechanics & Tunnelling Technology (JRMTT)**, 25 (1) 21-32.
- ii. Shanker, D. and Pathak, A. (2019). “Estimation of Source Parameter of local Earthquake in Tehri Dam Site and Vicinity”, **Journal of Rock Mechanics & Tunnelling Technology (JRMTT)**, 25 (2) 89-102.
- iii. Sangeeta, Maheshwari B.K. and Kanungo D.P. (2020), "GIS-based Pre-and Post-Earthquake Landslide Susceptibility Zonation with Reference to 1999 Chamoli Earthquake", **J. of Earth System Science** 129 55, 1-21, (<https://doi.org/10.1007/s12040-019-1319-y>)
- iv. Chidambaram, R.S. and Agarwal, P. (2019). “Shear resistance behavior of geo-grid confined RC elements under static and cyclic loading”, **Current Science** 117 (2), 260-271.

d. International Journals

- i. Luxman Kumar and J.P. Narayan (2020) Computation of ground motion amplification scenario in NCT Delhi for earthquake engineering purposes and seismic microzonation, **Pure Appl. Geophys.** (doi.org/10.1007/s00024-020-02420-4)
- ii. J.P. Narayan and Garima Yadav (2020) Effects of geometry and rheological parameters of large basin on the SH-wave response of sub-basin in the basin sub-basin models, *Journal of Seismol*, 24, 149–163 (doi.org/10.1007/s10950-019-09894-3).
- iii. Neeraj Kumar and J.P. Narayan (2019) Effects of site-city-interaction and polarisation of the incident S-wave on the transfer function and fundamental frequency of structures, *Natural Hazards* (<https://doi.org/10.1007/s11069-019-03671-8>).

- iv. Shukla, R.P., and Jakka, R.S., “Determination and Prediction of the Ultimate Bearing Capacity of a Strip Footing on Undrained Clayey Slopes”, **Acta Geotechnica Slovenica**, 16(2):50-65 (2019).
- v. Sharma, P., Mouli, B., Jakka, R.S. and Sawant, V.A., “Economical Design of Reinforced Slope Using Geosynthetics”, **Geotechnical and Geological Engineering** (Springer), 38 (2):1631-1637(2020).
- vi. Chamoli, B. P., Kumar, A., Chen, D.Y., Gairola, A., Jakka, R.S., Pandey, B., Kumar, P., Rathore, G., “A prototype earthquake early warning system for northern India”, **Journal of Earthquake Engineering**, Taylor & Francis, 1-19(2019). (Published Online: 24 Jun 2019).
- vii. Maheshwari B. K. and Kirar B. (2019), “Dynamic Properties of Soils at Low Strains in Roorkee Region using Resonant Column Tests.” **Int. J. of Geotechnical Eng.** 5, 399-410.
- viii. Padalu, P. K. V. R., Singh, Y., and Das, S. (2020). "Cyclic two-way out-of-plane testing of unreinforced masonry walls retrofitted using composite materials", **Construction and Building Materials**, 238, 117784(1-24).
- ix. Padalu, P. K. V. R., Singh, Y., and Das, S. (2020). "Tensile properties of wire and fibre reinforced cementitious matrix composites for strengthening of masonry", **Structures**, 23, 164-179.
- x. Padalu, P. K. V. R., Singh, Y., and Das, S. (2019). "Out-of-plane flexural behaviour of masonry wallettes strengthened using FRP composites and externally bonded grids: Comparative study", **Composites Part B: Engineering**, 176, 107302.
- xi. Padalu, P. K. V. R., Singh, Y., and Das, S. (2019). "Out-of-plane flexural strengthening of URM wallettes using basalt fibre reinforced polymer composite", **Construction and Building Materials**, 216, 272-295.
- xii. Yadav, D., Kwatra, N. and Agarwal, P. (2019). “Post-yield deformation parameters of reinforced concrete beam with corroded reinforcement”, **Structural Concrete** 20 (1), 318-329.

- xiii.** Tomar, A., Paul, D.K. and Agarwal, P. (2019). “Seismic assessment and retrofitting of a heritage brick masonry building using FRP”, **Journal of Earthquake and Tsunami**, 13 (01), 1950001
- xiv.** Chidambaram, R.S. and Agarwal, P. (2019). “Flexural behavior of reinforced concrete beams with high performance fiber reinforced cementitious composites”, **Journal of Central South University** 26 (9), 2609-2622
- xv.** Oinam, R.M., Kumar, P. C. A., and Sahoo, D. R., (2019). “Cyclic performance of steel fiber-reinforced concrete exterior beam-column joints”, **Earthquakes and Structures**, 16(5), 533-546.
- xvi.** Surana, M., Meslem, A., Singh, Y. and Lang, D.H. (2020). “Analytical evaluation of damage probability matrices for hill-side RC buildings using different seismic intensity measures”, **Engineering Structures** 207, 110254 (1-15), (DOI: 10.1016/j.engstruct.2020.110254).
- xvii.** Surana, M., Meslem, A., Singh, Y. and Lang, D.H. (2019). “Damping Modification Factors Observed from the Indian Strong-motion Database”, **Journal of Earthquake Engineering** (DOI: 10.1080/13632469.2019.1643809).
- xviii.** Adhikary, S., and Singh, Y. (2019). “Effect of site amplification on inelastic seismic response,” **Earthq. Eng. Eng. Vib.**, 18(3), pp 535–554, (DOI: 10.1007/s11803-019-0520-y).
- xix.** Kadam, S.B., Singh, Y. and Li, B. (2020). “Seismic fragility reduction of an unreinforced masonry school building through retrofit using ferrocement overlay”, **Earthquake Engineering and Engineering Vibration**, 19, 397–412.
- xx.** Kanaujia, J., Mitra, S., Gupta, S.C., Sharma, M.L., Crustal anisotropy from shear-wave splitting of local earthquakes in the Garhwal Lesser Himalaya. **Geophys. J. Int.**, 219 (2019) 2013–2033.
- xxi.** Yadav, D., Kwatra, N. and Agarwal, P. (2020). “Comparative post-yield performance evaluation of flexure member with

- corroded reinforcement”, **Structure and Infrastructure Engineering** (<https://doi.org/10.1080/15732479.2020.1731557>).
- xxii.** Bharathi, M., Dubey, R.N. and Shukla, S.K. (2019). “Experimental investigation of vertical and batter pile groups subjected to dynamic loads”, **Soil Dynamics and Earthquake Engineering**, 116, pp. 107-119.
- xxiii.** Bajaj, S. and Sharma, M.L. (2019). “Modeling Earthquake Recurrence in the Himalayan Seismic Belt Using Time-Dependent Stochastic Models: Implications for Future Seismic Hazards”, **Pure and Applied Geophysics**, (<https://doi.org/10.1007/s00024-019-02270-9>).
- xxiv.** Das, R., Sharma, M.L., Wason, H.R., Choudhury, D. and Gonzalez, G. (2019). “A Seismic Moment Magnitude Scale”, **Bulletin of the Seismological Society of America**, 109 (4), 1542-1555.
- xxv.** Mittal, H., Wu, Y.M., Sharma, M.L., Yang, B.M. and Gupta, S. (2019). “Testing the performance of earthquake early warning system in northern India”, **Acta Geophysica**, 67(1), 59-75.

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