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# Cooperation between NGI & IIT Roorkee

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# FORUM FOR PROMOTION OF SOIL DYNAMICS IN INDIA

Roorkee, 21 December 2013

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# Cooperation between NGI & IIT Roorkee

- NGI started scientific cooperation with IIT Roorkee from 2003/2004 as part of a larger package of research cooperation coordinated by NOR SAR
- The funding agencies were the Norwegian Ministry of Foreign Affairs and the Norwegian Embassy in Delhi
- The cooperation was through the "Institutional Cooperation Program between India and Norway".
- The first program of 3 years cooperation focused on (among others):
  - Seismic hazard in the Himalayas
  - Seismic risk to gravity dams on rock
  - Seismic response of tunnels in rock



# Cooperation between NGI & IIT Roorkee

- The project provided funds for buying a number of softwares, including UDEC and 3DEC for seismic analysis of fractured/jointed rocks based on DEM.
- To achieve the objectives, several visits were arranged in Oslo and Roorkee to exchange views and results, train the PhD students, etc.
- The results of the cooperation were published in a number of papers on tunnels and dams during the 13SEE in Roorkee in 2006.
- In addition, a separate 1-day workshop was held during 13SEE to promote the cooperation and disseminate the results.

# Cooperation between NGI & IIT Roorkee

## Observations from the first phase of the project:

- No barrier/reservations in the cooperation
- Increased openness and friendship between the two sides
- The cooperation was motivating for the Indian students, and they contributed immensely to the quality and quantity of the research output.
- The cooperation contributed to additional support to IITR by the Dept. of Science and Technology.
- We (from Norway) were impressed by the will from the Indian authorities to invest in research and spending money on that.
- The scientific community in India is very strong on the subject, but somewhat fragmented.
- The cooperation was so positive that we made every effort to get approval for an extension of the cooperation into phase 2.



# Cooperation between NGI & IIT Roorkee

- The second phase of cooperation lasted between 2007 and 2010.
- New experts with structural background joined the project and a new partner (Wadia Inst. of Himalayan Geology) was added
- The cooperation focused on:
  - Seismological studies in North-East India
  - Seismic response of slopes (which is a major issue in the foothills of Himalayas).
  - Soil amplification (by SASW, H/V, soil testing and modelling)
  - Liquefaction (model testing, field and laboratory testing)
  - Modelling of concrete and masonry structures, and seismic risk to buildings (the capital city of the state of Uttarakhand)



# Cooperation between NGI & IIT Roorkee

- The results of the cooperation were published in a number of journal papers and 14SEE articles.
- In addition, a 1-day workshop was held during 14SEE.
- Several Indian PhD students performed their research on various topics of cooperation. For example, high-quality work was performed on characterization and seismic response of a major slope near Mussorie and on soil liquefaction resulting in joint papers (examples):
  - Pal, S., Kaynia, A.M., Bhasin, R.K and Paul, D.K. (2012). Earthquake stability analysis of rock slopes: a case study. *Rock Mechanics and Rock Engineering*, Vol. 45 (2), 205-215.
  - Maheshwari, B.K., Kale, S.S., and Kaynia, A.M. (2012). Dynamic properties of Solani Sand at large strains: a parametric study. *Int. Journal of Geotechnical Engineering*, volume 6 (3), July, 353-358.



# Cooperation between NGI & IIT Roorkee

- The successful second phase of cooperation resulted in funding of the third phase of research from 2014.
- New institutions were added to the program including the seismological Institute of Bhutan.
- The cooperation focused on:
  - Seismological studies in Bhutan
  - Application of seismic risk models in phase two to other regions in India.
  - Large-scale mapping of seismic response of slopes.
  - Topographic amplification (through measurement and numerical modelling)
  - Development of methodologies for assessment of seismic response of buildings in hilly areas.



# Summary

- The cooperation between NGI and IIT Roorkee has been very fruitful and instructive.
- New ideas (at international level) have merged from these interactions.
- Friendships have been established and nurtured during the visits by the two sides.
- The two sides got access to larger networks.
- Joint publications have expanded outreach of partners.
- Because of the vast pool of qualified students and motivated teachers, it is believed that the Indian experts can play a major international role if they cooperate at national level and interact more at international level.