Model of 260.5m high Tehri Dam Project (Uttarakhand)

Tehri PSP (U/S Bifurcation) (UK)

Baglihar HEP Stage-II (J&K)

Kameng HEP (Arunachal Pradesh)

Tehri PSP (Inlet/Outlet) (UK)

Technical Memorandum No. 84
(For Official Use Only)

उत्तराखंड शासन

Annual Report 2013-14

Irrigation Research Institute
(An ISO 9001 : 2008 Certified Organisation)
Roorkee - 247 667

Website : www.iriroorkee.com
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Phone: 01332 - 265174/257501
Fax :01332 - 262487

May, 2014

Consultancy Areas

IRI undertakes Research and Development activities related to Irrigation and Hydro-electric Projects in the following major areas :

- Providing efficient and economical hydraulic design for various engineering works viz.
  - Canal works, Spillways, Power House, Intakes.
  - Diversion Works, Surge Tanks, Sediment Excluding and Ejecting Devices.
  - Siting of Bridges and Barrages.
  - River Training, Flood Protection and Anti-erosion measures.
- Geotechnical Investigations and Concrete Mix Design and Material Testing for all Civil Engineering Structures.
- Economical design of Concrete Mixes using Flyash and Superplasticizers; Roller Compacted concrete for Massive Structures.
- Ground Water Development
  - Conjunctive Use of Sub-surface and Surface Water, Water logging.
  - Suitability for Canal Linings, Seepage from Canals, Tubewell.
  - Stability due to Sub-surface flow, Water Suitability.
  - Studies for Regeneration/Seepage from Water Bodies.
  - Artificial Recharging
- Sedimentation Studies
  - Capacity and Life of Reservoirs.
- Mathematical Modeling
  - Hydrological Events
  - Sub-surface flow, Surface flow.
  - Hydraulic Structures etc. (Surge Tank, Water Hammer and Sedimentation Chamber)
- Basic & Fundamental Research in the field of Water Resources.

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Annual Report
2013-14

An ISO 9001:2008 Certified Organization

Irrigation Research Institute
Roorkee - 247 667(Uttarakhand)

May, 2014

हरीश रावत

मुख्यमंत्री, उत्तराखण्ड

उत्तराखण्ड सचिवालय
देहरादून - 248 001
फोन : 0135-2755177
0135-2650433 (का.)
फैक्स : 0135-2712827

सन्देश

मुझे यह जानकर हर्ष हो रहा है कि उत्तराखण्ड सिंचाई विभाग के अधीन शोध एवं विकास सम्बन्धी कार्यरत संस्था सिंचाई अनुसंधान संस्थान, रूड़की वर्ष 2013–14 में किये गये विभिन्न अनुसंधान, प्रतिरूप अध्ययन एवं परीक्षण कार्यों की 84 वीं वार्षिक विवरणिका प्रकाशित करने जा रहा है।

इसी शताब्दी में सृजित उत्तराखण्ड राज्य में जल संसाधन एवं अन्य छोटे–बड़े जल स्रोतों का अपूर्व भण्डार है। भारत में जल विद्युत परियोजनाओं को स्थापित करने हेतु अपार क्षमताओं का भण्डार उपलब्ध है। वर्तमान में भारत में जल विद्युत क्षमता लगभग 84 हजार मेगावाट है जबकि मात्र एक–चौथाई ही इसका दोहन हो पाया है। इस प्राकृतिक सम्पदा का जन कल्याण हेतु उपयोग किये जाने में राष्ट्रीय एवं अन्तराष्ट्रीय स्तर पर बढ़ते ऊर्जा एवं जल संकट का समाधान करने में सिंचाई अनुसंधान संस्थान, रूड़की की महत्वपूर्ण भूमिका निभा रहा है।

विवरणिका में प्रकाशित वैज्ञानिक/अभियन्ताओं के शोध कार्य युवा वैज्ञानिकों के लिये लाभदायक एवं प्रेरणाप्रद होंगे, ऐसा मेरा विश्वास है।

विवरणिका 2013–14 के सफल प्रकाशन हेतु शुभकामनायें।

(हरीश रावत)

यशपाल आर्य
सिंचाई मन्त्री

उत्तराखण्ड सरकार

अ.शा.प.सं. – 991 / कैम्प / VIP / 14
विधान भवन
कक्ष नं0 19–20
देहरादून – 248 001
फोन : (0135)–2666304 (का.)
फैक्स : (0135)–2666308 (का.)
फोन : (0135)–2530222 (आ.)

दिनांक : 18–05–2014

सन्देश

मुझे यह जानकर अत्यन्त प्रसन्नता हो रही है कि विगत वर्षों की भाँति सिंचाई अनुसंधान संस्थान, रूड़की अपनी 84वीं वार्षिक विवरणिका का प्रकाशन करने जा रहा है।

यह संस्थान उत्तराखण्ड राज्य में ही नहीं अपितु देश–विदेश में चल रहे विभिन्न जल–विद्युत एवं सिंचाई परियोजनाओं के निर्माण कार्यों को सम्पादित करने हेतु शोध, परिकल्पन एवं प्रतिरूप अध्ययनों को सम्पन्न करने में महत्त्वपूर्ण स्थान रखता है। उत्तराखण्ड में पूर्व में निर्मित महत्त्वपूर्ण जल विद्युत परियोजनाओं के प्रतिरूप अध्ययन भी इस संस्थान द्वारा किये गये हैं एवं भविष्य में भी राज्य में अनेकों महत्त्वपूर्ण जल विद्युत परियोजनाओं के प्रतिरूप अध्ययन का कार्य इस संस्थान द्वारा किया जायेगा। इन महत्त्वपूर्ण कार्यों को सुचारू रूप से सम्पादित करने हेतु संस्थान के मुख्य अभियन्ता एवं उनके अधीनस्थ कार्यरत समस्त अधिकारी एवं शोध कर्मी प्रशंसा के पात्र हैं।

मुझे पूर्ण विश्वास है कि संस्थान के अभियन्ता एवं वैज्ञानिक भविष्य की आवश्यकताओं को दृष्टिगत रखते हुए देश में उपलब्ध जल संसाधनों के उचित दोहन, उपयोग, संरक्षण एवं प्रबन्धन में पारस्परिक समन्वय से अपना महत्त्वपूर्ण योगदान प्रदान करेगें।

84वीं वार्षिक विवरणिका के सफल प्रकाशन हेतु सिंचाई अनुसंधान संस्थान, रूड़की के समस्त अभियन्ताओं, वैज्ञानिकों एवं कर्मचारियों को मेरी हार्दिक शुभकामनायें।

आपका

(यशपाल आर्य)

डा० अजय कुमार प्रद्योत
Dr. Ajay Kumar Pradyot

उत्तराखण्ड सरकार

सचिव, सिंचाई एवं बाढ़ नियन्त्रण, खेलकूद,
अल्पसंख्यक कल्याण, युवा कल्याण
Secretary, Irrigation & Flood Control
Sports, Minorities Welfare, Youth Welfare,
Govt. of Uttarakhand,
4, Subhash Marg, Dehradun
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E-mail : ajaipradyot1@yahoo.com

Message

It is a matter of great pleasure that Irrigation Research Institute, Roorkee is publishing its 84th Annual Report which contains its R&D activities carried out during the year 2013-14.

IRI Roorkee is known for its significant contribution in the field of R&D activities related to Hydraulic Modelling studies, Material Testing, Ground Water Studies and Concrete Technology.

I am happy to learn that IRI Roorkee has been associated with prestigious projects like Tehri PSP (Uttarakhand), Ratle H.E.Project (Jammu & Kashmir), Miyar H.E. Project (Himachal Pradesh), Kali Singh Dam Project (Rajasthan), Kanhar Dam Spillway (Uttar Pradesh), Soma Sissiri Hydro Electric Project (Arunachal Pradesh), Dibbin H.E. Project (Arunachal Pradesh), Seli H.E Project (H.P), Baglihar H.E. Project Stage-II (J&K), Rampur H.E.Project (H.P), Upper Mersyangdi-2 H.E. Project (Nepa!), Anandpur Barrage (Orissa), Kameng H.E.Project {A.P}, Bogibill Barrage across river Brahamaputra (Assam), Naitwar Mori H.E. Project (Uttarakhand), Rangit Stage-IV H.E.Project (Sikkim), Lata Tapovan H.E.Project (Uttarakhand).

Through this, I take an opportunity to wish to compliment all the engineers and research personnel for their continued efforts in carrying out research activities at IRI, Roorkee.

I wish all success for the publication of Annual Report 2013-14.

(Dr. Ajai Kumar Pradyot)

V.K. Tamta

Chief Engineer & HOD
Irrigation Department, Uttarakhand
Dehradun

Message

It is a matter of great pleasure that Irrigation Research Institute, Roorkee is publishing its 84th annual report highlighting its technical achievements during the year 2013-14.

IRI, Roorkee is a very old and premier Institute in the field of Hydraulic Mode!ing and Testing of Engineering Materials. IRI Roorkee was initially established as a research unit in 1928 at Lucknow and shifted its activities to Bahadrabad campus in 1945, situated on the left bank of Ganga Canal in Haridwar district. The unit was upgraded to Research Institute in 1954 at Roorkee. Since then it has taken an important and lead role in developing hydro-electric power generation in India.

During the year 2013-14 the Institute has taken up big leap in undertaking R&D activities of many projects like Tehri PSP (Uttarakhand), Ratle HE Project (Jammu & Kashmir), Miyar HE Project (Himachal Pradesh), Kali Sindh Dam Project (Rajasthan), Kanhar Dam Spillway (Uttar Pradesh), Soma Sissiri Hydro Electric Project (Arunachal Pradesh), Dibbin HE Project (Arunachal Pradesh), Seli HE Project (H.P), Baglihar HE. Project Stage II (J&K), Rampur HE Project (H.P). Upper Mersyangdi-2 HE Project (Nepal), Anandpur Barrage (Orissa), Kameng HE Project (A.P), Bogibill Barrage across river Brahamaputra (Assam), Naitwar Mori HE Project (Uttarakhand), Rangit Stage-IV HE Project (Sikkim), Lata Tapovan HE Project (Uttarakhand) etc.

During the year, 39 research reports and 100 test reports were issued. In addition, a manual on hydraulic model studies was prepared by the research personnels involved in carrying out the model studies at Field Research Institute, Bahadrabad, which shows relentless efforts of the engineers. scientists and staff of the IRI. I take this opportunity to compliment engineers, scientists and staff of IRI, Roorkee for their excellent work done during the year 2013-14 and hope that the publication of this annual report will help the end-users and the same momentum will be maintained in the years to come.

I wish all success for publication of annual report 2013-14.

(V.K. Tamta)

A.K. Dinkar
B.Sc. Engg. (Hons.), M.E., M.B.A.

Chief Engineer (Design) & Director
Irrigation Research Institute
Roorkee - 247 667 (Uttarakhand)

Message

I am happy to present the 84th annual report of IRI, Roorkee giving details of R&D activities carried out by different research units during the year 2013-14. The Institute has taken a lead role not only in the field of hydraulic model studies for major hydro-electric projects but also in providing consultancy services of ground Water recharge for two districts of Haryana State, During the year, the Hydraulic Model Research Station of IRI, Roorkee located at Banadrabad has conducted model studies of small and large hydroelectric projects and flood protection works viz Tehri PSP (Uttarakhand), Ratle HE Project (Jammu & Kashmir), Miyar HE Project (Himachal Pradesh), Kali Sindh Dam Project (Rajasthan), Kanhar Dam Spillway (Uttar Pradesh), Soma Sisslri Hydro Electric Project (Arunachal Pradesh), Dlbbin HE Project (Arunachal Pradesh), Seli HE Project (H.P), BagliMar HE Project Stage II (J&K), Rampur HE Project (H.P), Upper Mersyangdi-2 HE Project (Nepal), Anandpur Barrage (Orissa), Kameng HE Project (A.P), Bogibill Barrage across river Brahamaputra (Assam), Naitwar Mod HE Project (Uttarakhand), Rangit Stage-IV HE Project (Sikkim), Lata Tapovan HE Project (Uttarakhand) etc.

Some important activities of the Institute during 2013-14 are mentioned below:

- During the year, 39 research reports and 100 test reports were issued, In addition, a manual on hydraulic model studies was prepared by the research personnels involved in carrying out the model studies at Field Research Institute, Bahadrabad, which shows relentless efforts of the engineers, scientists and staff of the IRI.
- Model studies carried out for Tehri Pump Storage Plant (TPSP).
- Consultancy services rendered to the Haryana State on Ground Water Recharging projects for Gurgaon and Mahendragarh Districts of Haryana.

I appreciate the remarkable efforts of all personnels of the Institute towards R&D activities related to present day scenario of irrigation & hydroelectric projects through applied and field oriented research. A Institute report is an excellent medium to disseminate its scientific creativity and its findings to the engineering fraternity.

I wish to express my gratitude to all the sponsors for their continued trust & belief in our R&D activities, I express my sincere thanks to research personnel and engineers who are working hard and are ready to undertake upcoming challenges.

Jal Hind

(A. K. Dinkar)

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SECTION - A
GENERAL REPORT

(a) GENERAL

Irrigation Research Institute, Roorkee (Formerly U.P.I.R.I.) was initially established as a small research unit in the year 1928 at Lucknow, the Capital of North Central Province during British era. The purpose of this unit was to carry out Research and Development works related to Irrigation Canal projects being executed by the U.P. Irrigation Department. Mr.Gerald Lacey, the pro-pounder of very popular regime theory for the design of irrigation canals in alluvial soils, was the founder of the above unit. The success of this research unit boosted up the confidence of practicing engineers and hence the research activities were further expanded when the aforesaid unit was shifted to a small town at Bahadrabad in 1945, which is located on the bank of Northern Ganga Canal near Haridwar on the national highway. Later on, it raised to a full fledged Research Institute in 1954 at Roorkee. The institute gradually developed as a pioneer research station of the country, which is providing facilities essentially for hydraulic model studies, testing of almost all types of civil engineering materials and basic / applied research related to hydroelectric projects, civil engineering structures, flood protection, canal works etc. In addition, it also provides consultancy services on planning, design and constructions of canal and river valley projects to all the state governments, central government departments and private engineering organisations such as U.P.P.W.D.,Public Health Engineering Deptt., Haryana, U.P. State Bridge Corporation Limited, National Hydro-Electric Power Corporation (NHPC), Rail India Technical and Engineering Services (RITES), Tehri Hydro Development Corporation (THDC), Hindustan Construction Company (HCC) Ltd. Satluj Jal Vidut Nigam Ltd. (SJVN Ltd.), GVK Ltd. Secundrabad, Lanco Infrastructure, Dans Energy Ltd., Teesta Jal Urja Ltd. GMR Consultancy by Angelique International Pvt. Ltd, Hydel / Irrigation Departments of Chatisgarh, Odisha, Uttar Pradesh, Haryana, Himachal Pradesh, J&K, Gujrat, Sikkim etc.

A list of important studies carried out for different projects of national and international importance is shown under the title 'Important projects/ R&D studies carried out in past by Irrigation Research Institute Roorkee.

(b) Important Model Studies / R&D activities carried out for different Projects by IRI Roorkee in the past :

- Tehri Dam Hydro-Electric Project (Uttarakhand).
- Hasan Dam (Republic of Yemen).
- Nyabarango Hydro-Electric Project, Rawanda,(East Africa).
- Upper Marsyandi Hydro-Electric Project, (Nepal).
- Baglihar Hydro-Electric Project J&K, (India / Pakistan).
- Vishnu Prayag Hydro-Electric Project (Uttarakhand).
- Maneri Bhali Project (Uttarakhand).
- Nathpa Jhakri Hydro-Electric Project (Himachal Pradesh).
- Ban Sagar Project Mirzapur (Uttar Pradesh).
- Karcham Wangtoo Hydro-Electric Project (Himachal Pradesh).
- Teesta Hydro-Electric Project (Sikkim).
- Tenga Dam Hydro-Electric Project (Arunachal Pradesh).
- Lahchura Dam, Mahoba (Uttar Pradesh).
- Vishnugad Pipalkoti Hydro-Electric Project (Uttarakhand).
- Rongni Chu Hydro-Electric Project (Sikkim).
- Rangit Hydro-Electric Project (Sikkim).
- Lower Rajghat Canal Lalitpur (Uttar Pradesh).
- Saurashtra Branch Canal Project (Gujrat).
- Koteshwar Hydro-Electric Project (Uttarakhand).
- Baspa Barrage (Himachal Pradesh).
- Kameng Hydro-Electric Project (Uttarakhand).
- Srinagar Hydro-Electric Project (Uttarakhand).
- Hydraulic model studies of under sluice pocket and sediment excluder at Virbhadra Barrage (Uttarakhand).
- Polavaram Project (Andhra Pradesh).
- Design of Sharda Type fall for Canals (A Basic Research Study).
- Design of surge systems under transient conditions for different H-E Project (A Basic Research Study).
- Evolving criterion for design of energy dissipaters at low Froude Number.
- Revision and Updating of Manual on Canal Lining (A Basic Research Study).
- Development of high performance concrete for Srinagar & Vishnu Prayag Hydro-Electric Projects (Uttarakhand).
- Impact Type Energy Dissipaters for Ranipur Super passage (A Basic Research Study).
- Design of roller compacted concrete for Jamrani Dam Project (Uttarakhand).
- Hydraulic model studies of Miyar H.E.Project (Distt. Lahaul & Spiti, Himachal Pradesh).

- Yamuna H. E. Scheme Stage II, Throttled Surge Tank for Chhibro Power House - A Model Study.
- Hydraulic model studies for diversion tunnel of Dibbin H.E.Project (Arunachal Pradesh).
- Model studies for revised proposal of Jorethang Loop Hydro Electric Project (Sikkim).
- Model studies for Bajoli Holi Hydro Electric Project (Himachal Pradesh).
- Model studies for desilting chamber, reservoir flushing and hydraulic performance of power intake of Teesta-III Hydro Electric Project (Sikkim).
- Model studies for Rongnichu Hydro Electric Project (Sikkim).
- Model Studies for Desilting Chamber Rangit H.E Project (Sikkim).
- Model studies of de-sander for Teesta H.E. Project Stage-VI (Sikkim).
- Model Studies for Dam Spillway for Greater Shillong Water supply Scheme (Meghalaya).
- Model Study for Tail Fall of Escape Channel of W.Y.C. H.E. Project Stage-II (Haryana).
- Design of spurs (A Basic Research Study).
- Studies for hydraulic design of Excluder (A Basic Research Study).
- Hydraulic design of stilling basin for Ghagra Barrage (Uttar Pradesh).
- Sharda sediment Ejector A prototype study & Sharda type fall stilling basin design.
- Siting barrage across Ram Ganga River at Hareoli.
- Training river Yamuna above Tajewala for E.Y.C.
- Study for siting barrage across river Yamuna near Tajewala (Uttar Pradesh).
- Hydraulic design of Obra Dam spillway (Uttar Pradesh).
- Training river Great Gandak in Nepal Territory.
- Hydraulic Model Studies for Kalisindh dam project (Rajasthan).
- Hydraulic Model Studies for Baitarani Hydro-electric project (Odisha).
- Revision of a Chapter-V on Sediment Transport for Publication No. 204 of CBI&P, New Delhi.
- Design of barrage floor for three dimensional seepage flow (A Basic Research Study).
- Design of Syphon Aqueduct (A Basic Research Study).
- Design of side training walls (A Basic Research Study).

It was very great pleasure for me to visit and study the very interesting and high scientific level researches carried out in the laboratory

Prof. Emil Mosonyi
Budapest Tech University

(c) Major Studies Carried Out During 2013-14 :

- Model Study for Upstream Bifurcation, Downstream Bifurcation and TRT Inlet / Outlet of Tehri Pump Storage Plant, (Uttarakhand)
- Model studies for Reservoir Sedimentation Studies of Ratle H.E. Project. (Distt. Kishtwar) (J&K)
- Hydraulic Model Studies for Optimisation of Stilling Basin & Reservoir Sedimentation of Miyar H.E.P. (Himachal Pradesh)
- Model Studies for Vortex Studies of Ratle H.E.Project (Distt. Kishtwar) (J&K)
- Hydraulic Model Studies of Kali Sindh Dam Project (Rajasthan).
- 2 D Model Studies for Kanhar Dam Spillway (Distt. Sonbhadra, U.P)
- 2 D Model Studies for Soma Sissiri Hydroelectric Project (Arunachal Pradesh)
- Model Studies for Spillway of Dibbin HEP (Arunachal Pradesh)
- Model Studies for Sedimentation of Seli H.E.P. (Distt. Lahaul & Spiti, Himachal Pradesh).
- Further Hydraulic Model Studies of Miyar H.E.P. (Himachal Pradesh)
- Model Studies for Optimization of Energy Dissipater of Kanhar Dam Spillway (Distt. Sonbhadra, UP)
- Physical Model Studies for Mass Oscillations in Water Conductor System of Baglihar H.E.P. Stage-II (J&K)
- Model Studies for Power Intake & Reservoir Sedimentation of Dibbin HEP (Arunachal Pradesh)
- Model Studies for Reservoir Sedimentation of Seli H.E.P. (Distt. Lahaul & Spiti, Himachal Pradesh)
- Model studies for Penstock bifurcation of Rampur Hydro Electric Project (HP)
- Model Study for Desilting Chamber of Upper Mersyangdi-2 HEP (Nepal)
- Physical Model Study of Rail Bridge Proposed on Hindon River near Noida (UP)
- Further model studies for Anandpur Barrage (Orissa)
- Model Studies for Water Conductor System of Kameng Hydro-Electric Project - 600 MW (AP)
- Compilation and Analysis of Observations Recorded at Meteorological Observatory, Hydraulic Division-II, Bahadrabad during Year 2013
- Model Studies for Rail cum Road Bridge across River Brahmaputra at Bogibil near Dibrugarh in Assam (Post Flood 2012)
- Model Studies for Barrage of Naitwar Mori H.E.P. across River Tons in Distt. Uttarkashi (Uttarakhand)
- Final Report of Model Studies for Desilting Chamber of Rangit (Stage-IV) H.E Project (Sikkim)
- Model Studies for Barrage intake of Lata-Tapovan H.E.P. across River Dhauli Ganga in Distt. Chamoli (Uttarakhand)

(d) Technical / Research Papers Published During 2013-14

(i) Verification of Different Formulae Laid Down in IS 9108: 1979 For Discharge Measurement

Authors:

- Aditya Kumar Dinkar, Chief Engineer (Design) & Director IRI, Roorkee.
- Dr. Subhash Mitra, Superintending Engineer, IDO, Roorkee.
- Shankar Kumar Saha, Executive Engineer, IRI, Roorkee.
- Ajay Kr. Sharma, Executive Engineer, IRI, Roorkee.

(Paper published in Seminar on "Hydrometry" (13-14th February 2014) at CWPRS, Pune).

(ii) Ground Water Recharge in District Gurgaon (Haryana)

Authors:

- Aditya Kumar Dinkar, Chief Engineer (Design) & Director IRI, Roorkee.
- L. K. Sharma, Superintending Engineer, IRI, Roorkee.
- O. P. Arora, Asstt. Research Officer, IRI, Roorkee.

(Paper published in All India Seminar on "Conservation and Protection of Underground Water" (20-21th September 2013) at Institute of Engineers (India), Uttarakhand State Centre, Dehradun).

(e) PUBLICATIONS

The following are the types of publications which were issued during the year 2013-14

(i) **Annual Report -** Annual Report for the year 2012-13 was published giving the brief account of the technical activities of the institute, including the important studies carried out, papers presented, research reports and test reports issued during the year.

(ii) **Technical Papers and Research Reports -** During the year 2013-14, few Technical Papers were published in different journals/ seminars and a total number of 39 Research Reports were issued by the Institute on the basis of studies carried out by different research units. A List of the Research Reports and Technical Papers under different titles are given in Section-B and the abstracts of the Research Reports as well as Technical Papers are given in Section-C.

(iii) **Test Reports -** Test reports are issued on the basis of field or laboratory tests carried out by the respective divisions. During the year 2013-14,100 test reports pertaining to various projects/agencies were issued. The details are given in Section-D.

(iv) **Technical News -** The Institute publish a quarterly technical news letter highlighting the R&D activities regarding the model studies/in-situ & lab tests carried out, studies in progress, training programmes, technical papers/reports published. The four issues of the technical news letter were published during the year highlighting various activities.

(f) LIBRARY

The Institute library has a rare and large collection of technical books, journals, reports and other publications. The IRI library possesses Indian and foreign publications related to the field of water resources, hydropower, ground water, mathematical modeling, geotechnical engineering, earth sciences, rock mechanics, engineering geology etc. There are approximately 25000 books in the IRI library at Roorkee and 3000 books at Field Research Station (F.R.S), Bahadrabad.

(g) CO-ORDINATION WITH OTHER INSTITUTIONS

The institute is a member or represented on technical/high level committees of the following organisations:

- Indian National Committee on Hydraulic Research (INCH), New Delhi.
- Central Ground Water Board (CGWB), Faridabad.
- Central Board of Irrigation and Power (CBI&P), New Delhi.
- National Geophysical Research Institute (NGRI), Hyderabad.
- Indian National Committee on Irrigation and Drainage (INCID)
- Institution of Engineers (India).
- Bureau of Indian Standards, New Delhi.
- International Congress On Large Dams (ICOLD).
- Ganga Flood Control Commission (GFCC)

(h) CO-ORDINATION WITH DIFFERENT ORGANIZATIONS LOCATED AT ROORKEE.

(i) Indian Institute of Technology Roorkee.

- Department of Civil Engineering.
- Department of Water Resources Development and Management Training.
- Department of Earthquake Engineering.
- Department of Hydrology
- Alternate Hydro Energy Centre.

(ii) National Institute of Hydrology, Roorkee.

(iii) Central Building Research Institute, Roorkee.

(iv) Central Institute of Mining & Fuel Research, Regional Centre, Roorkee.

(i) REPRESENTATION AT HIGH LEVEL COMMITTEES

The Chief Engineer (Design) & Director I.R.I., Roorkee is a member of the following high level committees:

- Technical Advisory Committee (TAC) on State Flood Projects
- Indian Road Congress.
- Chief Engineer's Committee of State.
- C.B.I.&P. Technical Committee on Management of Floods.
- Advisory Committee on Engineering Construction Technology of Council of Science & Technology, Lucknow, U.P.
- Science and Technology Advisory Committee of Ministry of Water Resources, New Delhi (STAC-MOWR).
- Governing Council of CWPRS, Pune.
- Academic Council, Indian Institute of Technology, Roorkee.
- Protective Works Committee of I.R.C., Ministry of Surface Transport, Govt. of India.
- Committee on Research and Future Development chaired by Advisor, Planning Commission, New Delhi.
- Sub-committee of the Indian National Committee on Hydraulic Research (INCH), New Delhi.
- Working Group of National Institute of Hydrology, Roorkee
- Sectional Committees of Bureau of Indian Standards (BIS), New Delhi.

SECTION - B
LIST OF PUBLICATIONS
RESEARCH REPORTS AND TECHNICAL/RESEARCH PAPERS

(a) RESEARCH REPORTS

(i) HYDRAULIC RESEACH UNIT - I

Hydraulic Research Unit - I mainly deals with the model studies for river training and flood protection works, siting of bridges, barrages, head regulators, silt ejectors and excluders, energy dissipaters and pump canals. Its work station is situated at Bahadrabad. Important studies carried out by this division during the year are as follows:

Sl. No.	R.R. No.	TITLE OF REPORT
(1)	84 RR (H_1-02)	A Research Report on Reservoir Sedimentation Studies of Ratle H.E. Project. (Distt. Kishtwar, J & K)
(2)	84 RR (H_1-03)	A Research Report on Hydraulic Model Studies for Optimisation of Stilling Basin & Reservoir Sedimentation of Miyar H.E.P. (Himachal Pradesh)
(3)	84 RR (H_1-04)	A Research Report of Model Studies for Vortex Studies of Ratle H.E.P. (Distt. Kishtwar, J&K)
(4)	84 RR (H_1-05)	A Research Report on Hydraulic Model Studies of Kalisindh Dam Project (Rajasthan)
(5)	84 RR (H_1-06)	2 D Model Studies for Kanhar Dam Spillway (Distt. Sonbhadra, UP)
(6)	84 RR (H_1-07)	2 D Model Studies for Soma Sissiri Hydroelectric Project (Arunachal Pradesh)
(7)	84 RR (H_1-08)	Model Studies for Spillway of Dibbin HEP (Arunachal Pradesh)
(8)	84 RR (H_1-09)	A Research Report on Further Hydraulic Model Studies of Miyar H.E.P. (Himachal Pradesh)
(9)	84 RR (H_1-10)	A Research Report of Model Studies for Sedimentation of Seli H.E.P. (Distt. Lahaul & Spiti, Himachal Pradesh)

(10)	84 RR (H_1-11)	Model Studies for Optimization of Energy Dissipater of Kanhar Dam Spillway (Distt. Sonbhadra, UP)
(11)	84 RR (H_1-12)	A Research Report on Physical Model Studies for Mass Oscillations in Water Conductor System of Baglihar H.E.P. Stage-II (Jammu & Kashmir)
(12)	84 RR (H_1-13)	Model Studies for Power Intake & Reservoir Sedimentation of Dibbin HEP (Arunachal Pradesh)
(13)	84 RR (H_1-14)	Model Studies for Reservoir Sedimentation of Seli H.E.P. Distt. Lahaul & Spiti (Himachal Pradesh)
(13A)	84 RR **(**H_1-01**)**	Annual Report Hydraulics Research Unit - I, 2013-14

(ii) HYDRAULIC RESEARCH UNIT - II

Hydraulic Research Unit II, generally deals with physical hydraulic modeling of dams, spillways, energy dissipaters devices, canal structures, intake and outlet works, flushing of reservoirs, desilting chamber of power channels and siting of weirs and barrages etc. In addition to physical hydraulic modeling, the division also take up works of mathematical modeling of desilting chambers, surge shafts, and water hammering etc. The division maintains a class "B" meteorological observatory and an automatic weather station (AWS) for observing various climatic parameters/conditions at Hydraulic Research Station Bahadrabad. Various studies carried out by this division during the year are as follows:

Sl. No.	**R.R. No.**	**TITLE OF REPORT**
(14**)**	84 RR **(**H_2-01**)**	Annual Report Hydraulics Research Unit - II
(15)	84 RR (H_2-02)	Model Study for Desilting Chamber of Upper Mersyangdi-2 HEP (Nepal)
(16)	84 RR (H_2-03)	Physical Model Study of Rail Bridge Proposed on Hindon River near Noida (U.P)
(17)	84 RR (H_2-04)	Further model studies for Anandpur Barrage (Orissa)
(18-19)	84 RR (H_2-05&06)	Model Studies for Water Conductor System of Kameng Hydro-Electric Project - 600 MW (Arunachal Pradesh)
(20)	84 RR (H_2-07)	Compilation and Analysis of Observations Recorded at Meteorological Observatory, Hydraulic Division-II, Bahadrabad during Year 2013
(21)	84 RR (H_2-15)	Model studies for penstock bifurcation of Rampur Hydro Electric Project (HP) April 2013

(iii) BASIC RESEARCH UNIT - II

The unit is actively involved with the hydraulic studies related to the medium and high head hydroelectric projects. The main thrust is towards the evolution of optimal hydraulic design for Intake structures, Spillways, Energy Dissipation Arrays, Stilling Basins, Sediment Exclusion Devices, Trench Weirs, Surge Tanks, Optimal location of Dams and Bridges and allied structures.

In addition, the division has a good facility for rating of current meters, which is unique of its kind in northern India. The division has been carrying out current meter rating work for various sponsors. The division is maintaining library and computer centre at the Hydraulic Research Station, Bahadrabad. Studies carried out during the year are as follows:

Sl. No.	R.R. No.	TITLE OF REPORT
(22)	84 RR (H_3-01)	Model Studies for Rail cum Road Bridge Across River Brahamaputra at Bogibill Near Dibrugarh in Assam (Post Flood 2012)
(23)	84 RR (H_3-02)	Annual Report Hydraulics Research Unit - III
(24)	84 RR (H_3-03)	Model Studies For Barrage of Naitwar Mori H.E.P. Across River Tons in Distt. Uttarakashi, (Uttarakhand)
(25)	84 RR (H_3-04)	Final Report of Model Studies for Desilting Chamber of Rangit (Stage-IV) H.E. Project (Sikkim)
(26)	84 RR (H_3-05)	Model Studies for Barrage-Intake of Lata-Tapovan H.E.P. Across River Dhauliganga in Distt. Chamoli, (Uttarakhand)

(iv) GROUND WATER RESEARCH UNIT - I

Ground Water Research Unit - I, generally, caters the need of groundwater physical and mathematical modeling of various hydraulic structures. The division also maintains an isotope laboratory which deals with usage of tracers in estimation of discharge in mountainous stream and also in detection of seepage/leakage from hydraulic structures. Besides this, the division also maintains a Library, which fulfills the need of the researchers of the institute as well as that of field engineers and research scholars of other organizations.

Sl. No.	R.R. No.	TITLE OF REPORT
(27)	84 RR (GW_1-01)	Annual Report Ground Water Research Unit - I

(v) GROUND WATER RESEARCH UNIT- II

This Unit has a well established EHDA laboratory where the study based on 2-D and 3-D physical modeling of hydraulic structures is carried out to determine the uplift pressures and exit gradient beneath the hydraulic structures founded on alluvium and permeable soil. The Electro-Hydro Dynamic Analogue (EHDA) technique commonly known as Electrical Analogy technique essentially deals with the study of seepage flow below the complicated hydraulic structures of Irrigation projects. In addition to this, studies related to artificial ground water recharge, seepage losses from watercourses and minors by Ponding Method are also dealt in canal lining laboratory of this division. The report presents various studies carried out during the year are given below :

Sl. No.	R.R. No	TITLE OF REPORT
(28)	84 RR (GW_2-01)	Annual Report Ground Water Research Unit - II.
(29)	84 RR (GW_2-02)	Hydraulic Performance of Pressure Release Valves
(30)	84 RR (GW_2-03)	Detail Project Report (DPR) of Artificial Recharge to Ground Water , Sohna Block, Distt. Gurgaon (Haryana)

(vi) BASIC RESEARCH UNIT - I

Basic Research Unit is, generally, responsible for the maintenance of Computer Center of the Institute, organizing computer courses for officers and staff of Irrigation Department. In addition, the division has facility to measure discharge in lined / unlined canals. Presently Pentium computers and peripherals are available in the computer center to meet the present day challenges. The computer centre has also facilities for A_0 size digital scanner and colored printer.

Digitization of old Research Reports, Research Papers & Manuals etc issued by Institute are also being done so as to help in preserving important documents in soft copy for research personnel's.

The division also maintains a Remote Sensing and GIS Laboratory, which was established in 1997. Since then, the laboratory is engaged in studies using remote sensing techniques with computer aided technology. Data related to water management projects are presented in GIS data base and other studies pertaining to water resources development are being carried out. With the advent of digital computers, the photo-elastic technique is not being used for the estimation of stresses, although Photo-Elastic Laboratory of the division has got capabilities to carry out these studies. Various studies carried out by this division during the year are:-

Sl. No.	R.R. No.	TITLE OF REPORT
(31)	84 RR (B - 01)	Annual Report of Basic Research Unit -I
(32)	84 RR (B - 02)	Assessment of Land Use/Land Cover analysis in Kanpur City and Its Surroundings

(vii) MATERI AL TESTING UNIT - I

The Material Testing Unit - I deals with the study of design of concrete mix including roller compacted concrete, high performance concrete and fiber reinforced concrete for construction of dams and other structures. This Unit mainly deals in the following area:-

(i) Design of concrete mix including roller compacted concrete, high performance concrete and fiber reinforced concrete for construction of dams and other structures.

(ii) Statistical laboratory is engaged in performing the statistical analysis of hydro-meteorological data.

(iii) Laboratory tests for determining the suitability of physical properties of different types of construction materials which are given below:

(a) Coarse and Fine aggregate i.e. sieve analysis, specific gravity, crushing value, impact value, soundness, flakiness index, elongation index and abrasion value etc.

(b) Tests for bricks and brick tiles i.e. compressive strength, water absorption, transverse strength etc.

(c) Tests for cement i.e. standard consistency, setting time, soundness, fineness, specific gravity, compressive strength etc.

(d) Tests for tor steel & welded joints i.e. tensile strength etc.

(e) Test for green and hardened concrete i.e. compressive strength of c.c. cubes, transverse strength of c.c. beams, unit weight, slump test and abrasion test etc.

(f) Tests for sheathing ducts for pre-stressed cables such as workability, tension load, transverse load and water loss.

Today has been my first opportunity to observe both the model research and the actual construction of large Indian Projects

Peter Rogers
Harvard University

Sl. No.	R.R. No.	TITLE OF REPORT
(33)	84 RR (MT_1-01)	Design of Concrete Mixes for Construction of Ram Ganga Barrage at Bareilly. (U.P.).
(34)	84 RR (MT_1-02)	Design of Concrete Mix for Govt. Polytechnic Bagpat (U.P.).
(35)	84 RR (MT_1-03)	Design of Concrete Mix for Over Head Reservoirs under Water Supply distribution system in Roorkee.
(36)	84 RR (MT_1-04)	Design of Concrete Mix for Govt. Polytechnic in village Jansat, Meerut (U.P.).

(viii) MATERIAL TESTING UNIT - II

This unit deals with the determination of engineering properties of rock mass and rock samples received from different hydroelectric/river valley and irrigation projects. Besides this annual report and quarterly news letter of the Institute are also published by the division as it maintains the publication section of the Institute. The important works carried out by the division during the year are given below : -

Sl. No.	R.R. No.	TITLE OF REPORT
(37)	84 RR (MT_2-01)	Annual Report Material Testing Unit-II.
(38)	84 RR (MT_2-02)	Analysis of Data for the Realistic Assessment of Bearing Capacity by Plate Load Test A Case Study

(ix) SOIL RESEARCH UNIT- I

The Soil Research Unit - I, comprises of three sub-divisions each having a well equipped Laboratory. The division is mainly working in the following area:

(a) Laboratory testing for the determination of engineering properties of soils.

(b) Field investigations for determination of

(i) Bearing capacity at foundation of structures.
(ii) In-situ Shear Parameters
(iii) Modulus of Subgrade Reaction
(iv) In-situ Permeability and Sub-Soil Strata to study the seepage behavior etc.

The laboratory and field tests of soil are generally carried out in accordance with relevant Indian Standards. Laboratory tests include soil classification, shear parameters, consolidation, permeability, maximum and minimum density etc. and special tests like, dispersability on clay materials, large size tri axial shear (200 mm dia. specimen upto a maximum pressure of 20 kg/cm^2), compressibility and permeability tests on rockfill material etc are performed and field tests include standard penetration test,

subgrade reaction test, block shear test, In situ dry density and permeability tests are also conducted. Various studies carried out by this division during the year are :

Sl. No.	R.R. No.	TITLE OF REPORT
(39)	84 RR (S_1-01)	Annual Report Soil Research Unit -I

(b) TECHNICAL/RESEARCH PAPERS

Sl. No.	Title of Paper	Authors Name	Paper Published in
1	Verification of Different Formulae Laid Down in IS 9108: 1979 For Discharge measurement	Aditya Kumar Dinkar, CE Dr. Subhash Mitra, SE Shankar Kumar Saha, EE Ajay Kr. Sharma, EE	Seminar on "Hydrometry" (13-14th February 2014) at CWPRS, Pune
2	Ground Water Recharge in District Gurgaon (Haryana)	Aditya Kumar Dinkar, CE L. K. Sharma, SE O. P. Arora, ARO	All India Seminar on "Conservation and Protection of Underground Water" (20-21th September 2013) at Institute of Engineers (India), Uttarakhand State Centre, Dehradun

I am very pleased to see further development of the station since my last visit about three years back, very important researches are being carried out, which would lead to efficient and economical hydraulic structures, I wish the staff all success

D.V. Joglekar
Director, CWPRS, Pune

SECTION- C
RESEARCH REPORTS & TECHNICAL/RESEARCH PAPERS INFORMATORY ABSTRACTS

(a) RESEARCH REPORTS

The section contains only the abstract of the Research Reports Published during the year by various divisions. For detail information regarding study, the TM nos. have been mentioned.

(i) HYDRAULIC RESEARCH UNIT – I

(1) An Research Report on Reservoir Sedimentation Studies of Ratle H.E. Project .(Distt. Kishtwar, J & K) (3D Geometrical Similar Model on Scale 1:55)

84RR (H_1-02)

Hydraulic Physical Model studies were conducted with a geometrical similar 3D model on 1:55 scale (discharge scale 1:22434) for reservoir sedimentation studies of Ratle Hydro Electric Project, Distt. Kishtwar, Jammu and Kashmir. After model studies it was found that

about 56 % & 47 % of the sediment deposited in the reservoir, sediment concentrations 1594 PPM & 1305 PPM passed through main orifice spillway and of 1420 PPM & 534 PPM passed through power intake at equilibrium conditions when model was run at 4000 Cumec feeding with sediment concentration of 3500 PPM and 1964 Cumec feeing with sediment concentration of 1772 PPM respectively. No vortices /rotational flow were observed in front of power intake during sedimentation studies.

(2) A Research Report on Hydraulic Model Studies for Optimisation of Stilling Basin & Reservoir Sedimentation of Miyar H.E.P. (Himachal Pradesh) (3D Geometrical Similar Model on Scale 1:25)

84RR (H_1-03)

Earlier model studies were conducted on a geometrical similar model built on scale 1:25 for determining the suitability of barrage axis & location of power intake, adequacy of waterway, etc. of Miyar H.E.P.(H.P.) Model studies indicated that barrage at 20m downstream of initially proposed barrage axis would be optimal location as described in Interim Report No. (1) 82-RR(H1-01) Dec 2011.

Later on sponsor shifted the barrage axis 20 m d/s and current studies were carried out for suitability of axis, adequacy of waterway, optimization of stilling basin and sedimentation / flushing, etc. Model studies indicated that 4 nos.

sluice bays of 6m (W) x 4m (H) gave satisfactory flow condition. Discharge of 1500 cumec passed at F.R.L. (El. 2845.0 m) in one bay inoperative condition. The pressures on spillway & breast wall profiles, along abutment & pier were found positive. A stilling basin of about 70 m length and floor level around El. 2805.0 m with barrage axis at initially proposed location shows satisfactory hydraulic jump formation, with residual velocity of about 4 m/sec. As described in Interim Report that initially proposed barrage axis is not hydraulically efficient, it will be better to conduct further studies for optimization of stilling basin after shifting the barrage at hydraulically efficient location. Sediment was not properly flushed after flushing for a period of 3 hours in model.

(3) A Research Report of Model Studies for Vortex Studies of Ratle H.E.P. (Distt. Kishtwar, J & K) (3D Geometrical Similar Part Model on Scale 1:20)

84RR(H_1-04)

Hydraulic Physical Model studies were conducted with a geometrical similar 3D part model on 1:20 scale (discharge scale 1:1789) for the observations of possibilities of formation of vortices in the front of power intakes of Ratle Hydro Electric Project, Distt. Kishtwar, Jammu and Kashmir. After model studies, it was found that flow remained quite calm at both MDDL and FRL in front of power intakes. No vortices or rotational flows were observed in front of power

intake at any reservoir levels in between MDDL and FRL even at 130% & 150% of design discharge of the power intake and 50% opening of trash rack in the model.

(4) A Research Report on Hydraulic Model Studies of Kalisindh Dam Project (Rajasthan) (3D Geometrical Similar Model on Scale 1:80)

84RR (H_1-05)

3D model studies were conducted on a geometrical similar model on scale 1:80 for the optimization of rock cutting in Upstream and Downstream of Kalisindh Dam after incorporating stilling basin and energy

dissipaters for Q= 24308 Cumec. The hydraulic tests indicated that the very huge quantity of soil/ rock cutting will be required to pass the

design discharge in the upstream of the dam avoiding excessive afflux and smooth flow through each bays of the dam and to avoid backwater effect on the spillway and keeping minimum clear distance of 1.50 m between trunnion axis of the tainter gates and tail water level in the downstream. The rock cutting in the upstream and the downstream were made in different stages. The minimum required rock cuttings to pass 75% of PMF (i.e. at Q = 24308 cumec). are shown in Drg. Water levels from 400m upstream to 1000 m downstream are given in Table. Cross-sections of the river after cutting at 150 m & 300 m upstream and 25m, 50m, 100m, 300m, 500m & 1000m downstream of Dam axis are shown in Drgs.

(5) 2D Model Studies for Kanhar Dam Spillway (Distt. Sonbhadra), UP

84RR (H_1-06)

Hydraulic Physical Model studies were conducted with a geometrical similar flume model on 1:40 scale (discharge scale 1:10119.3) for Kanhar dam Spillway of Kanhar Dam Project, Distt. Sonbhadra, Uttar Pradesh. After model studies it was found that design flood (PMF) passes at estimated maximum water level (MWL) and in emergency

conditions, the discharging capacity of spillway is observed as 88.2% of design flood at MWL. Coefficient of discharge at PMF is worked out as 1.96. At 10% PMF and full PMF, negative pressures are observed within one-tenth of their corresponding heads over the crest under free flow condition while under gated condition the negative pressures were observed slightly more than one-tenth of head over the crest at FRL. A maximum length of the trajectory is observed as 66m from the end of bucket and its height above the tip of the bucket is observed of the order of 20 m. At lower discharge, hydraulic jump starts to form from 80 m d/s of dam axis while at design flood, it forms from 110m.

(6) 2D Model Studies for Soma Sissiri Hydroelectric Project (Arunachal Pradesh)

84RR (H_1-07)

Hydraulic Physical Model studies were conducted with a geometrical similar flume model on 1:60 scale (discharge scale 1:27885.5) of stilling basin and spillway of

proposed RCC Dam for Soma Sissri HEP, Arunachal Pradesh. After model studies, stilling basin with a reduced length of 2.50m from original designed length found hydraulically optimal. It was also found that design flood (PMF) passes about 2.80 m below the FRL through all gates and in emergency conditions, the discharging capacity of spillway is observed as 94.65% of design flood at FRL. Coefficient of discharge at design flood is worked out as 0.645. Negative pressures were observed within one-tenth of their corresponding heads over the crest under free flow condition while under gated condition the negative pressures were observed more than one-tenth of head

over the crest at FRL from 30 m to 54m d/s of dam axis. Formation of hydraulic jump starts to form from 150 m d/s of dam axis at different discharges. The minimum value of cavitation index was observed in the model as 0.217.

(7) Model Studies for Spillway of Dibbin HEP (Arunachal Pradesh)

84RR(H_1-08)

Hydraulic Physical Model studies were conducted with a geometrical similar comprehensive model on 1:40 scale (discharge scale 1:10119) of spillway and plunge pool of proposed dam for Dibbin HEP, Arunachal Pradesh. After model studies, it was found that design flood (PMF = 7380 cumec) passes about 1.00 m below the FRL through all gates and in emergency conditions, the discharging capacities of undersluice and spillway are

observed about 89% of design flood at FRL. Coefficients of discharge at their maximum discharging capacity of undersluice and spillway in isolation are worked out as 0.826 and 2.121 respectively. Negative pressures were observed of the order of 4.80 m at 55.0 m downstream of the crest along the abutment from bottom to 3.0 54m. Falling of the longest trajectory is observed about 20 m beyond the end of plunge pool. The minimum value of cavitation index was observed in the model as 0.367. A maximum residual velocity of the order of 23 m/sec was observed in the downstream of plunge pool.

(8) A Research Report on Further Hydraulic Model Studies of Miyar H.E.P. (Himachal Pradesh) (3D Geometrical Similar Model on Scale 1:25)

84RR (H_1-09)

Earlier model studies were conducted on a geometrical similar model built on scale 1:25 for determining the suitability of barrage axis &

location of power intake, adequacy of waterway, etc. of Miyar HEP(H.P.). For better hydraulics of the project, new barrage axis was shifted at 400m upstream of initially proposed barrage axis providing 4 nos. sluice bays of 6m (W) x 4m (H). Model studies indicated that barrage at new location gave satisfactory flow condition. Discharge of 1000 cumec passed at F.R.L. (El. 2845.0 m) in one bay inoperative condition. The pressures on spillway & breast wall profiles, along abutment & pier were found positive. A stilling basin of about 60 m length and floor level around El. 2816.50 m shows satisfactory hydraulic jump formation, with residual velocity of about 3.45 m/sec. Formation of intermittent surface swirls/rotational flows were observed inside the power intake near trash rack from MDDL to 5 m below the FRL. After flushing for a period of 3 hours in the model, sediment was almost flushed out up to 100 m upstream of barrage and beyond this, about 50-55% sediment was flushed. Deposition of sediment in the intake pool was also observed during sedimentation. The maximum sediment

entering the power intakes after 30 hours running of model was observed of the order of 15% of the total silt load.

(9) A Research Report of Model Studies for Sedimentation of Seli H.E.P. (Distt. Lahaul & Spiti, Himachal Pradesh) (3D Geometrical Similar Model on Scale 1:60)

84RR (H_1-10)

Hydraulic Physical Model studies were conducted with a geometrical similar 3D model on 1:60 scale (discharge scale 1:27885) for reservoir sedimentation studies of Seli H.E.

Project, Disstt. Lahaul & spiti, Himachal Pradesh. After model studies, it was found that about 88.67% of the sediment deposited in the reservoir, sediment concentration 182 PPM passed through main orifice spillway and of 137 PPM passed through power intake at equilibrium conditions when model was run at 1260 Cumec feeding with sediment concentration of 1478 PPM. No vortices/rotational flow were observed in front of power intake during sedimentation studies in the model.

(10) Model Studies for Optimization of Energy Dissipater of Kanhar Dam Spillway (Distt. Sonbhadra, UP)

84RR (H_1-11)

Hydraulic Physical Model studies were conducted with a geometrical similar flume model on 1:40 scale (discharge scale 1:10119.3) for Kanhar dam Spillway of Kanhar Dam Project, Distt. Sonbhadra, Uttar Pradesh. Kanhar Dam Project is proposed to construct a

39.6 m high earthen dam across river Kanhar, a tributary of river Sone for providing Irrigation in district Sonbhadra and Mirzapur. Ogee shaped spillway of concrete is proposed in the centre of river course to spill design flood of 29148 cumec. Depending upon the head, discharge intensity, tail water condition and nature of bed material, etc, ski-jump bucket with lip angle 37^0 and of radius 18.00 m was provided at invert level El 230.00 m, was proposed for the energy dissipation in the downstream of the spillway. After Model studies, it is observed that the ski-jump bucket with lip angle 37^0 and radius 17.00 m at invert level El 230.00 m was found hydraulically optimal.

(11) A Research Report on Physical Model Studies for Mass Oscillations in Water Conductor System of Baglihar H.E.P. Stage-II (Jammu & Kashmir)

84RR (H_1-12)

Physical model studies for the surge shaft and tail race system of Baglihar H.E. Project Stage-II (J&K) were conducted to determine the maximum and minimum surge levels in U/s Surge Shaft & D/s collection gallery. The physical model was built on exaggerated model scales. The test results indicated that the maximum & minimum observed surge levels in surge shaft of 27.5 m dia under worst load

transients of upsurge and downsurge were El. 859.50 m and El. 825.0 m against the computed surge levels at El. 861.07 m and El. 814.82 m respectively. The flow conditions in the surge tank, collection gallery and d/s of outfall were found satisfactory. The maximum & minimum

surge levels in D/s Collection Gallery was found at El. 721.0 m and El. 709.00 m maintaining tail water level at El. 717.20 m. The maximum & minimum surge levels in D/s Collection Gallery was found at El. 709.0 m and El. 702.00 m maintaining tail water level equal to 706.20 m.

(12) Model Studies for Power Intake & Reservoir Sedimentation of Dibbin HEP(Arunachal Pradesh)

84RR (H_1-13)

Hydraulic Model studies were conducted with a geometrical similar 3D comprehensive Physical model on 1:40 scale (discharge scale 1:10119) for investigating the possibilities of vortices formation in front of the power intake as well as studies of reservoir sedimentation/flushing of proposed Dibbin Hydro Electric Project to be located in Distt. West Kameng, Arunachal Pradesh. The model studies suggested the formation of intermittent to continuous surface dimple: coherent swirls of maximum diameter 40 cm with a maximum depression of 1.20 m in front of power intake of prototype in all runs of the model. The model was run at two different discharges of 1748 cumec and 600 cumec feeding with sediment concentration of 400 PPM and 2000 PPM each. The result of sediment deposition in the reservoir in terms of percentage and its passing through the undersluice as well as power intake at equilibrium condition are shown in Tabular form. At equilibrium condition, approximately 72% of sediment was found to have deposited in the reservoir with maximum sediment passing through undersluice and power intake as 1745 PPM and 680 PPM respectively.

(13) Model Studies for Reservoir Sedimentation of Seli H.E.P. (Distt. Lahaul & Spiti, Himachal Pradesh)

84RR (H_1-14)

Hydraulic Model studies were conducted with a geometrical similar 3D comprehensive Physical model on 1:60 scale (discharge scale 1:27885) for the study of sedimentation/ flushing of reservoir for proposed Seli H.E. Project, Disstt. Lahaul & spiti, Himachal Pradesh.

The experiments were carried out at our Hydraulic Research Station, Bahadrabad for three different discharges of 1260 cumec, 800 cumec and 400 cumec under different conditions with sediment concentration of 1478PPM, 580 PPM and 280 PPM respectively. Among the 5 tested conditions, the condition No. 5 (with 50% clogging of power intake) appears to give adverse situation as 87% (minimum) of sediment was found to have deposited in the reservoir with maximum quantity (172 PPM) of sediment entering the power intake. The result of sediment deposition in the reservoir in terms of percentage and its concentration passing through the sluice bays as well as power intake at saturation condition are shown in Tabular form.

(ii) HYDRAULIC RESEARCH UNIT - II

(14) Annual Report of Hydraulic Div.-II

84RR (H_2-01)

Hydraulic Division-II, one of the four Divisions of Hydraulic Circle of Irrigation Research Institute (IRI) Roorkee, generally caters to the physical hydraulic modeling of the various hydraulic structures. Model studies for various components of hydro-electric projects and barrages have been conducted during 2013-14.

(15) Corrigendum to Technical Memorandum No. 82 - RR (H2-15) Model studies for penstock bifurcation of Rampur Hydro Electric Project (HP) April 2013

82RR (H_2-15)

The physical hydraulic model study for penstock bifurcation of Rampur Hydro Electric Project (Himachal Pradesh) was conducted on a distorted model. At design discharge, discharge distribution in all three pressure shafts was observed. It is almost equal in all the

shafts. Also, 75% and 110% of the design discharge of 384.88 cumec was allowed to pass in the model and discharge distribution through the penstocks was found almost equal. Flow observed is almost streamline in the model. No suppression of flow and formation of eddies was observed at y-junction in the model. Pressure under steady state condition with tailpool levels 1010.0 m and 1024.0 m are found positive at all operating conditions. Under steady state condition (with one machine closed and tail pool water level at 1024.0m), a maximum pressure of the order of 151.00 m and maximum pressure pulsation of the order of (+)0.93 m are observed. Maximum hydrodynamic pressure of the order of 189.54 m was observed under load transient 50% -100% - 0% with tailpool level 1010.0 m and 195.62 m was observed under load transient 100% - 0% with tailpool level 1024.0 m

(16 Model Study for Desilting Chamber of Upper Mersyangdi-2 HEP (Nepal).

84RR (H_2-02)

The hydraulic model studies for modified desilting chamber were carried out on a geometrically similar physical model built to scale 1:15 for Upper Mersyangadi desilting chamber (392.555 m including upstream and

downstream transitions) is hydraulically efficient in trapping and flushing the suspended sediments.The after run conditions of the chamber (7.7 hours in proto) did not indicate any choking or failure of the system. The overall flushing efficiency of the chamber is quite satisfactory as no opening was found chocked after experiments. No significant silt deposition was seen inside the flushing duct.

(17) Physical Model Study of Rail Bridge Proposed on Hindon River near Noida (UP), TM No. 84 RR (H2- 03) August 2013.

84RR (H_2-03)

The hydraulic model studies for Rail bridge across River Hindon near Noida (U.P.) were carried out on a geometrically distorted model built to scale 1:150 (horizontal) & 1:20 (vertical). On the basis of model studies, a 192.6 m long bridge comprising four equal spans of length

48.15 m has been found adequate to pass the design discharge of 3680 cumec without any harmful interference and recommended for construction. Suitable training works at abutments of the bridge as well as at downstream left embankment have also been recommended.

(18) Further model studies for Anandpur Barrage (Orissa), TM No. 84 RR (H2-04) Nov. 2013

84RR(H_2-04)

Physical model studies were carried out for Anandpur Barrage, Odisha, across river Baitarni having a waterway of 491.60 m to eradicate non-uniform discharge distribution through barrage bays as well as under sluice bays. The studies have been conducted on geometrically similar scale model built to the scale of 1:60. The hillock removal from right bank upstream of barrage along with cutting of high ground levels downstream of right most barrage bays and under sluice have been recommended to make the discharge distribution uniform across the barrage bays as

well as the under sluice bays as compared to the arrangement of spurs. Right and left guide bunds are working satisfactorily.

(19) Model Studies for Water Conductor System of Kameng Hydro-Electric Project - 600 MW (Arunachal Pradesh), TM No. 84 RR (H2- 05) Dec. 2013.

84RR (H_2-05 & 06)

The physical hydraulic model study for water conductor system of Kameng Hydro Electric Project -600 MW (Arunachal Pradesh) was Conducted on a distorted hydraulic model. No backflow was observed at Tenga intake at any transient condition. No vortex formation was Observed at HRT intake, Tenga intake and in

surge shaft. No negative pressure was observed at any piezo point in the whole water Conductor System. Maximum upsurge of 801.75 m was observed in transient 50-100-0

at FRL and minimum downsurge of 738.00 m was observed in transient 0-100 at MDDL in the model. Maximum pressure of the order of 706.38m was observed at the end of penstock (Piezo point No.17) in Tenga open case with transient 50-100-0.

(20) Compilation and Analysis of Observations Recorded at Meteorological Observatory, Bahadrabad.

84-RR (H_2-07)

Various elements of meteorological observations such as temperature, relative humidity, rainfall, wind velocity, vapour pressure, sediment concentration and evaporation rate were observed at Meteorological Observatory, hydraulic

Division-II, Bahadrabad in the year 2013. Maximum and minimum temperature of the year was 41.2ºC on 24-05-2013 and 0.5ºC on 09-01-2013. Out of total of total 1133.5 mm rainfall of the year 2013, about 68.79% of total yearly rainfall was received from only June to August. The wettest month of the year was June 2013 in which 327.2 mm rainfall was observed. Total numbers of rainy days were 68. Maximum average wind velocity was 5.4 km/hr on 09-05-2013 and max. Vapour pressure of 27.9 mm was observed on 25-07-2013. Max. rate of evaporation, 8.3 mm/day, was observed on 09-05-2013. A total evaporation loss during the year was 953.2mm. Maximum sediment concentration in the feeder channel of HRS was observed as 8800 ppm on 16-06-2013.

(iii) BASIC RESEARCH UNIT- II

(21) Annual Report of Hydraulic Division - III

84RR (H_3-02)

Hydraulic Division-III was established in May 1965, since then model studies pertaining to Various hydraulic structures such as dams, diversion structures, spillways, outlets, intake of hydro-electric projects, desilting arrangements, canal and bypass for power houses, surge tanks are being conducted in this division during the year 2013-14.

(22) Model Studies for Rail cum Road Bridge across river Brahamputra at Bogibil near Dibrugarh in Assam (Post Flood 2012)

84RR (H_3-01)

The model studies were carried out by IRI Roorkee to observe the behaviour of manmade structures and safeguard the guide bunds of Bogibil Bridge having waterway of 4875 m, across river Brahmaputra with the river bed configuration of post flood 2012 with proposal of pilot channels. The studies have been conducted on the existing physical model built to horizontal scale of 1:400 and vertical scale of 1:50. The observations during hydraulic tests indicated that attack on south guide bund reduced, however the discharge in North Channel along north guide bund increased with comparison to last year and both guide bunds were found to be working satisfactorily.The proposed pilot channel drew water at 10000 cumec to 25000 cumec discharges and it was activate.

(23) Model Studies For Barrage of Naitwar Mori H.E.P. across river Tons in Distt. Uttarkashi (Uttarakhand).

84 RR (H_3-03)

Model Studies were conducted for barrage of Naitwar Mori Hydro Electric Project (NMHEP)

proposed to be constructed across river Tons in Distt. Uttarkashi (Uttarakhand) on agoometrically similar model built to the scale

1:30. Observations of the hydraulic test results indicated that the proposed clear water way 27.3 m with barrage crest at El.1254.0 m (Drg. 07) was found to be adequate to pass the design flood of 1600cumec at El. 1263.8 m with all bays fully opened, while only two bays are sufficient to pass the 1600 cumec at El. 1268 m (MWL). Coefficient of discharge for barrage bays was worked out to be 1.773 for design flood of 1600 cumec. The design discharge of intake 88.2 cumec passes through intake at reservoir level El. 1261.6 m.

(24) Final Report of Model Studies for Desilting Chamber of Rangit (Stage- IV) H.E Project (Sikkim).

84 RR (H_3-04)

Model studies were conducted for proposed Desilting Chamber of Rangit (Stage IV) H.E. Project on a geometrically similar model built to scale of 1:15. To obtain uniform flow in the chamber, two vertical and one slopping vanes were provided in the diffuser as proposed by sponsor, which gave better velocity distribution in the chamber. The overall silt trapping efficiency of the chamber with vanes in diffuser is 82.92 % at 3000 ppm and 79.67 % at 5000 ppm, while it is 80.00 % at 3000 ppm and 77.00 % at 5000 ppm without vanes in diffuser. Later on, sponsor desire to test only vertical vanes in diffuser which gave slightly less velocities in the chamber, and overall silt trapping efficiency of the order of 81.89 % at 3000 ppm and 78.73 % at 5000 ppm. Studies of silt flushing efficiency indicate some sediment deposition in chamber, which is required to be flushed in the clear water after monsoons as required. Later on sponsor desire to conduct model studies to determine the effect of river water levels on discharging capacity of SFT and reservoir levels. Curve between discharging capacity of SFT verses

river water levels and reservoir levels verses river water levels have been developed, which show decrees in discharging capacity and increase in reservoir level as river water level increases.

(25) Model Studies for Barrage-Intake of Lata-Tapovan H.E.P. across river Dhauliganga in Distt. Chamoli (Uttarakhand).

84 RR (H_3-05)

The Model studies were conducted for barrage-intake of Lata Tapovan hydroelectric project proposed to be constructed across river Dhauliganga in Distt. Chamoli (Uttarakhand) on a geometrically similar model built to the scale 1:30. Observations of the hydraulic test results indicated that the proposed clear water way of 132.0 m with barrage crest at El. 2090.0 m & undersluice crest at El. 2088.0 m was found to be adequate to pass the design discharge of 2000 cumec at El. 2093.84 m with all bays fully opened, while only eight bays are sufficient to pass the 2000 cumec discharge at El. 2096.5 m. The design discharge of HRT is 68.9 cumec. At FRL and MDDL the discharge carrying capacity of HRT is adequate. But the discharge carrying capacity of intakes at FRL is adequate, while at MDDL it is 87 % and 90 % of design

discharge 79.25 cumec with two chambers at 0.3m and 0.5m gate opening respectively

(iv) GROUND WATER RESEARCH UNIT- I

(26) Annual Report, Ground Water Division-I

84 RR (GW_1-01)

Ground Water Research Unit-I, one of the Unit of Research Circle of I.R.I., Roorkee generally caters to the needs of Groundwater physical and mathematical modeling of various hydraulic structures. The unit also maintains an isotope laboratory which deals with usage of tracers in estimation of discharge in mountainous stream and also in detection of seepage/leakage from hydraulic structures. In addition to this the unit also maintains a Library, which fulfills the needs of the researchers of the institute as well as that of field engineers and research scholars of other organizations.

(v) GROUND WATER RESEARCH UNIT- II

(27) Annual Report, Ground Water Division-II.

84RR (GW_2-01)

The studies and activities undertaken by the ground water division-2 during the year 2013-14 are documented in the report.

(28) Hydraulic Performance of Pressure Release Valves.

84 RR (GW_2-02)

'AQUA' ENGINEERING & GLOBAL MARKETING, Jaipur provided 01 Number flange and flap type Pressure Release Valve in this sub-Division for testing their hydraulic performance. The valve has been tested in horizontal position and with the slope of 1.5:1 as desired by sponsor. The test results are shown in tables. The hydraulic performance of Pressure release valve is very good and valve can be used for their purpose successfully.

(29) Detail Project Report (DPR) of Artificial Recharge to Ground Water , Sohna Block, Distt. Gurgaon (Haryana)

84 RR (GW_2-03)

This Detailed Project Report (DPR) has been prepared on behalf of Public Health Engineering Division, Sohna, Haryana Public Health Engineering Department, Distt. Gurgaon with a view to augment the depletion of ground water

reservoir to Sohna block, Distt. Gurgaon through the option of rainwater harvesting by way of construction of check dams, injection wells with or without bund construction at appropriate locations. At present, no arrangements are implemented for artificial recharge to ground water scheme in this area so far. This Artificial recharge to ground water scheme Sohna block, Distt. Gurgaon is a rainwater harvesting scheme to augment the ground water storage is prepared to utilize the annual runoff of 1.61 MCM coming from 8.17 km2 catchment areas of 14 sites near 12 villages of Sohna block Distt. Gurgaon. It envisages a construction of 14 Nos of 2 m high check dam of total length 1094 m along with 219 Nos. injection wells and 13 Nos. of observation wells of three different depths.the artificial recharge to ground water, Sohna block, District-Gurgaon Haryana is, therefore, a technically feasible, viable and eligible project for augmentation of ground water storage to avoid the decreasing the level of ground water table due to over-exploitation of ground water. The B/c Ratio of the project is estimated as less than

unity which may appear as less attractive at the first sight. However, considering that ground water tables is depleting day by day due to increase in population and development of agriculture, industry and urbanisation (networking of concrete), the cost of augmentation of ground water reservoirs shall be socially obligatory issue. Hence, implementation of this project is worth for consideration

(vi) BASIC RESEARCH UNIT- I

(30) Annual Report, Basic Division

84 RR (B-01)

Basic Research Unit-I, one of the Eight divisions of Research Circle of I.R.I. Roorkee is generally responsible for the maintenance of Computer Centre of the institute, organizing computer courses for officers and staff of irrigation department .This unit is also managed the Maintenance & Upgradation of Website of Irrigation Research Institute, Roorkee is alos managed by this Unit. In addition, the division caters discharge measurement in canals. Now this division is also conducts Capacity Survey and Sedimentation Studies of Reservoirs. The Division maintains a Remote Sensing Laboratory, established in 1997. The Remote Sensing laboratory is engaged in studies of water resources projects using remote sensing techniques with computer aided technology. The present report covers subject wise activities carried out in the division during the year 2013-2014 including Publications, Organizational set up and financial status of the division.

(31) Capacity Survey of Pili Reservoir

84 RR (H_4 - 01)

The Pili reservoir was created in 1961-62 by constructing an earthen embankment across river Pili in pargana Afzalgarh, District Bijnor. The reservoir was started to impound in 1966. The length of embankment bund is 8.85 km. with maximum height of 17.13 m in river portion. The reservoir is fed by the rivers Pili, Baneli and Dhara. The total catchment area of the reservoir is 162.00 sq.km. The design capacity of the reservoir at an elevation 257.86 m (F.R.L) is 55.265 MCM and dead storage capacity is 0.99 MCM at an elevation 246.89 m. The first hydrographic survey of Pili reservoir was conducted by field Engineer in the year of 1985, after filling the reservoir upto F.R.L. The capacity of the reservoir is determined as 41.4 MCM. The second hydrographic survey of Pili reservoir was conducted by Irrigation Research Institute, Roorkee in 1991. The capacity has been worked out to 42.21 MCM. The present capacity of the Pili reservoir worked out by Irrigation Research Institute, Roorkee is 39.20 MCM.

(32) Assessment of Land Use/Land Cover Analysis in Kanpur City And its Surroundings. (Basic Study)

84 RR (B-02)

For the Assessment of "Land Use/Land Cover Analysis in Kanpur City and its Surroundings" Remote Sensing Techniques have been adopted by using Erdas Imagine and Arc-View software. IRS-IA Satellites and IRS-IB Satellite has been used to find out the Assessment area of FCC during September 1988 and April 1996 respectively. Computer Aided Techniques have been used for Geo-reference, Classification and Accuracy assessment. The Report Emphasizes on the comparison of the above two FCC studies in the context of seven classes. The Study concludes that during the span of Eight year:

- Increase in Maximum Area of Barren Land - 352.07 Hectares.
- Decrease in Minimum Area of Forest Land - 339.30 Hectare.

(vii) MATERIAL TESTING UNIT- I

(33) Design of Concrete Mixes for Construction of Ram Ganga Barrage at Bareilly. (U.P.).

84RR (MT_1-01)

Present study was sponsored to design the concrete mixes for the concrete grades $A_{40}M_{10}$, $A_{40}M_{15}$ at slump (50±10)mm and $A_{20}M_{20}$ at slump (150±10)mm on the basis of 28 days compressive strength for construction of Ramganga Barrage on river Ramganga in Bareilly district of Uttar Pradesh by the Executive Engineer, Flood Division, Canal Colony, Bareilly. Study of concrete mix design for above grades of concrete has been carried out on 150mm size cube specimens. Portland Pozzolana Cement (Birla Cement) has been used in this study. Coarse aggregate (Crushed) and Fine aggregate (Natural & washed) have been used in the study of concrete mix design. High Range Water Reducing Admixture 'APCON ADDPLAST GF(M)' has been used in the study of concrete mix design for concrete grade $A_{20}M_{20}$ at slump (150±10)mm.

(34) Design of Concrete Mix for Govt. Polytechnic Bagpat (U.P.).

84RR (MT_1-02)

Present study was sponsored to design the concrete mix for the concrete grade A20M20 at slump (50±5)mm on the basis of 28 days compressive strength for construction of Govt. Polytechnic in village Kotana Banger of district Baghpat (U.P.) by the Project Manager, Unit-46, Construction & Design Services, U.P. Jal Nigam, Jail Chungi Road, Meerut. Study of concrete mix design for above grade of concrete has been carried out on 150mm size cube specimens. Portland Pozzolana Cement (Jay Pee Cement), Coarse aggregate (Crushed) and Fine aggregate (Natural) have been used in the study of concrete mix design.

(35) Design of Concrete Mix for Over Head Reservoirs under Water Supply distribution system in Roorkee.

84RR (MT_1-03)

Present study was sponsored to design the concrete mix for the concrete grade $A_{20}M_{30}$ at slump (50±5)mm on the basis of 28 days compressive strength for construction of 5 no. Over Head Reservoirs under Water Supply Distribution System in Roorkee Town by the Project Manager, Nagarjuna Construction Company Ltd., 458/10, Ramnagar, Roorkee. Study of concrete mix design for above grade of concrete has been carried out on 150mm size cube specimens. Ordinary Portland Cement-43 grade (ACC Cement), Coarse aggregate (Crushed), Fine aggregate (Natural) and High Range Water Reducing Admixture 'Dr. Fixit Pidicrete CF 51' have been used in the study of concrete mix design.

(36) Design of Concrete Mix for Govt. Polytechnic in village Jansat, Meerut (U.P.).

84RR (MT1-04)

Present study was sponsored to design the concrete mix for the concrete grade A20M20 at slump (50±5)mm on the basis of 28 days compressive strength for construction of Govt. Polytechnic in village-Jansat of district Meerut (U.P.) by the Project Manager, Unit-46, Construction & Design Services, U.P. Jal Nigam, Jail Chungi, Jail Road, Near Over Head Tank, Meerut. Study of concrete mix design for above grade of concrete has been carried out on 150mm size cube specimens. Portland Pozzolana Cement (Jay Pee Cement), Coarse aggregate (crushed) and Fine aggregate (natural) have been used in the study of concrete mix design.

(viii) MATERIAL TESTING UNIT- II

(37) Annual Report, Material Testing Division-II.

84RR (MT_2-02)

The report deals with activity and financial status of Material Testing Division - II, for the year 2013-14.

(38) Analysis of Data for the Realistic Assessment of Bearing Capacity by Plate Load Test - A Case Study

84RR [$HRU_2(MT_2$-01)]

This report deals with the compilation and analysis of Plate load test results for realistic assessment of bearing capacity at Lower Rajghat canal project which takes off from Rajghat dam constructed on the river Betwa 22 Km from Lalitpur in U.P. The strata at which the plate load tests were conducted comprises of clay & silty sand (sm) at 5.607 Km, silty sand (sp-sm) at 17.07Km, SM/(non plastic) at 23.525 km and GP/SPSM at 25.94 km. The dry density of the strata varies between minimum of 1.71 to maximum 2.00. The bearing capacity of the strata at different locations have been evaluated rationally as per methods available in prevailing Indian Standards and a realistic value has been obtained. The proposed width of foundation for different structures required to be constructed at different locations have been examined and its safety have also been assessed.

(ix) SOIL RESEARCH UNIT- I

(39) Annual Research Report, Soil Division-I.

84RR (S_1-01)

The studies and activities undertaken by the Soil Division - I during the year 2013 -14 are documented in the report.

(b) TECHNICAL/RESEARCH PAPERS

1- Verification of Different Formulae L aid Down in IS 9108 : 1979 For Discharge measurement (Authors: Aditya Kumar Dinkar, Dr. Subhash Mitra, Shankar Kumar Saha, Ajay Kr. Sharma) Paper published in Seminar on "Hydrometry" (13-14th February 2014) at CWPRS, Pune.

Abstract

A weir is an overflow structure in which there is a relationship between the depth of water over the crest and the discharge. Weirs are of mainly three types: Sharp crested, Broad Crested & Cippolete Weirs. When the head over the crest of a weir is more than 1.5 times or 2 times the width of the weir, it is called a sharp crested weir. A rectangular weir without end contractions (i.e., width of the channel is equal to the length of the weir) has the soundest experimental basis and gives most dependable results. That is why, this type of weir is preferred to measure discharge of small streams, canal, etc. than any other type. Sharp crested weir has the advantage due to fact that establishment of a rating curve is not required from field measurement. However, it is not suitable for streams carrying loads of silt and debris. The present paper discusses the validity and authenticity of different formula used for the flow measurement in open channel by sharp crested weir.

2- Ground Water Recharge in District Gurgaon (Haryana)
(Authors: Aditya Kumar Dinkar, L. K. Sharma, O. P. Arora)
Paper published in All India Seminar on "Conservation and Protection of Underground Water" (20-21th September 2013) at Institute of Engineers (India), Uttarakhand State Centre, Dehradun).

Abstract

Ground water in Gurgaon district, Haryana has been over exploited. Today, the stage of ground water development in the district is 209%, and it is 311% in one of its blocks owing to rapid urbanization, industrialization, and related activities. The area is a part of National Capital Region (NCR), and has shown a steep decline in water levels in urban/semi urban and rural areas. Heavy influx of population with annual growth rate of 5.9% and industrial development has put stress on natural resource like ground water. There is adverse effect on environment that imbalances the fragile ecosystem of the area as well as Gurgaon- the millennium city. The capacity building of ground water resource for sustainability of the present ground water abstraction structures, to put check on water level decline, and to improve ground water quality, is now essential for the area. Rain water harvesting and artificial recharge to ground water using modern techniques could provide solution to the ground water related issues and problems. Augmentation of ground water resource would in turn address the domestic / drinking water demand of the large population to a certain level.

(c) NEW INITIATIVE

1- "Manual on Physical Hydraulic Model Studies"

Preamble:

Hydraulics studies of any proposed hydraulic structure such as dam, spillway, bridge, canal, river training work, etc. are frequently undertaken as an aid to the designer. They permit the prior knowledge of the hydraulic behavior of proposed structure. Its main aim is to find out the useful quantitative and qualitative information which can be safely transformed to its prototype. A thorough knowledge of principles of model similitude is, therefore, necessary for the proper design, construction and operation of model and then, the interpretation of model tests. In order to corrects interpret and rightly predict from useful results obtaining by model studies for the performance of prototype, the art of engineering has to be practiced with experience, judgment, ingenuity, and patience for obtaining these results. So, an attempt has been tried to compile the basic principle of model studies, past experience of IRI, Roorkee and other institutions in this field, recent development in physical hydraulic model studies, judicious interpretations of result, etc. in the for form this manual.

The technical parts of this manual such as principles, guidelines, values, formulae/expression, test/ procedure, interpretation of results, construction of models, observations on models, etc. are compiled from various text books, BIS Codes, guidelines/ manual/technical book issued by various commissions/Board, etc., relevant papers available on internet, past experience, etc. Other items of this manual are prepared from details available on website of IRI, prevailing account procedure, etc. Whole manual is divided into five chapters. Chapter 1 deals with brief introduction about hydraulic modeling with its history, basic aspects, importance, purpose, limitations, future, etc. It also deals about organizational set up of IRI, Roorke to conduct various studies along with hydraulic model studies and outstanding contributions of IRI, Roorkee. Chapter 2 deals with modeling technique. Detailed procedures of model scale design, construction and its investigation are dealt in Chapter 3. Chapter 4 deals with the details of instrumentation implemented in the physical models and different flow parameters observed/taken on the models. Different data such as survey data, hydraulic data, sediment data, structural design data, etc. and terms of reference required to conduct a specific model studies are discussed in chapter 5.

A very impressive water management project and one that surely has stood the test of time. It must rank among the greatest Irrigation undertakings in the world

J F Kennedy
Chairman, IAHR

SECTION - D
TEST REPORTS

The section contains a list of Test Reports brought out during the year by various divisions. For detail informations regarding tests, the T. M. nos. have been mentioned.

(a) MATERIAL TESTING UNIT – I

Material Testing Division-I essentially deals with the design of concrete mix including roller compacted concrete, high performance concrete and fiber reinforced concrete for hydraulic structures. Concrete lab carries out various lab tests for determination of suitability of physical properties of different types of construction materials such as bricks, brick tiles, cement, aggregates, steel bars etc. as per laid IS codes. Some of the tests carried out during the year are:

Sl.No.	T R No.	Title of Test Report
(1)	84 TR (MT_1-01)	Physical properties of cement sample received from Khara Project Construction Division-1 (Rehabilitation), Haridwar.
(2)	84 TR (MT_1-02)	Physical properties of cement sample received from Nirman Khand-6, U.P. Avas & Vikas Parishad, Meerut.
(3)	84 TR (MT_1-03)	Physical properties of cement sample received from Flood Division, Canal Colony, Bareilly
(4-13)	84 TR (MT_1-04,24,25,31, 32,33,37,39,40,41)	Testing of tor steel received from Unit-46, Construction & Design Services, UP Jal Nigam, Meerut.
(14-15)	84 TR (MT_1- 05,11)	Testing of tor steel, bricks, coarse aggregate and fine aggregate received from Construction and Design Services, Unit-9, U P Jal Nigam, Meerut.
(16-21)	84 TR(MT_1-06,23,43,45, 49,50)	Testing of tor steel, bricks, c.c. cubes, coarse aggregate and fine aggregate received from Nirman Wing, Uttarakhand Payjal Sansadhan Vikas & Nirman Nigam, Rishikesh.

Sl.No.	T R No.	Title of Test Report
(22-23)	84 TR(MT_1-07,09)	Testing of c.c. cubes received from Construction Division, Uttarakhand Payjal Sansadhan Vikas & Nirman Nigam, Chamba (Uttarakashi).
(24-25)	84 TR(MT_1-08,12)	Testing of tor steel, coarse aggregate & fine aggregate received from Urban Works Unit, U.P. Jal Nigam, Muzaffarnagar.
(26)	84 TR (MT_1-10)	Testing of fine aggregate received from Irrigation Division, Uttarakashi.
(27-31)	84 TR (MT_1-13,14,28, 47,48)	Physical properties of cement sample received from Nirman Wing, Uttarakhand Payjal Sansadhan Vikas & Nirman, Rishikesh.
(32-40)	84 TR (MT_1-15,16,17, 18,19,20,21,26,27)	Physical properties of cement sample received from Irrigation Division, Uttakashi.
(41-42)	84 TR(MT_1-22,51)	Testing of fine aggregate received from Irrigation Division, Uttakashi.
(43)	84 TR (MT_1-29)	Physical properties of cement sample received from Unit-46, Construction & Design Services, UP Jal Nigam, Meerut.
(44)	84 TR(MT_1-30)	Physical properties of cement sample received from Nagarajun Construction Company Ltd., Ramnagar, Roorkee.
(45)	84 TR(MT_1-31)	Testing of coarse & fine aggregate received from Nagarajun Construction Company Ltd., Ramnagar, Roorkee.
(46-48)	84 TR(MT_1-35,38,46)	Testing of tor steel received from Temporary Construction Division, U P Jal Nigam, Shamali.
(49)	84 TR(MT_1-36)	Physical properties of cement sample received from Irrigation Division, Duggada.
(50)	84 TR(MT_1-42)	Testing of c.c. cubes received from Northern Railway, Roorkee.
(51)	84 TR(MT_1-44)	Testing of coarse & fine aggregate received from Irrigation Division, Duggada.
(52-57)	84 TR (MT_1-52,53,64,65, 72,73)	Testing of tor steel received from Unit-46, Construction & Design Services, UP Jal Nigam, Meerut .
(58)	84 TR(MT_1-54)	Testing of bricks received from Northern Railway, Roorkee.
(59)	84 TR(MT_1-55)	Testing of tor steel received from Construction Unit, U P Jal Nigam, Saharanpur.
(60)	84 TR(MT_1-56)	Physical properties of cement sample received from Northern Railway, Roorkee

Sl.No.	T R No.	Title of Test Report
(61)	84 TR(MT_1-57)	Testing of c.c. cubes received from Northern Railway, Roorkee.
(62)	84 TR(MT_1-58)	Testing of c.c. cubes received from Tunnel & Power House Division-2, Dehradun.
(63)	84 TR(MT_1-59)	Testing of tor steel, coarse & fine aggregate received from Urban Works Unit, U.P. Jal Nigam, Muzaffarnagar.
(64)	84 TR(MT_1-60)	Physical properties of cement sample received from Nagarajun Construction Company Ltd., Ramnagar, Roorkee.
(65)	84 TR(MT_1-61)	Testing of tor steel, coarse & fine aggregate received from Tunnel & Power House Division-2, Dehradun.
(66)	84 TR(MT_1-62)	Testing of c.c. cubes received from Irrigation Division, Ramnagar, Nainital.
(67)	84 TR(MT_1-,63)	Physical properties of cement sample received from Urban Works Unit, U.P. Jal Nigam, Muzaffarnagar.
(68-69)	84 TR(MT_1-66,67)	Testing of c.c. cubes, bricks, coarse & fine aggregate received from Irrigation Division, Roorkee.
(70)	84 TR(MT_1-68)	Testing of c. c. cubes received from Drainage Division, Muzaffarnagar.
(71)	84 TR(MT_1-69)	Testing of coarse aggregate received from U.J.V.N. Ltd., Joshiyara, Uttarkashi.
(72-73)	84 TR(MT_1-70,71)	Physical properties of cement sample received from Irrigation Division, Roorkee.
(74)	84 TR(MT_1-74)	Testing of coarse aggregate received from U.J.V.N. Ltd., Ganga Bhawan, Dehradun.
(75)	84 TR(MT_1-75)	Testing of tor steel, bricks, coarse aggregate and fine aggregate received from Unit-9, Construction and Design Services, U P Jal Nigam, Saharanpur.

This station needs to be developed as a Centre of excellence in hydraulic model studies, particularly in view of the large hydropower potential of the Himalayan region

A D Mohile
Chairman, Central Water Commission

(b) SOIL RESEARCH UNIT - I

The Soil Research Unit I, has three well equipped Soil laboratories. The division is mainly responsible for carrying out the laboratory testing for the determination of engineering properties of soils, field investigations for determination of Bearing Capacity of foundations, in-situ shear parameters, modulus of sub grade reaction, in-situ permeability and sub-soil strata to study the seepage behavior etc.

Sl.No.	T R No.	Title of Test Report
(76)	84 TR (S_1-02)	Laboratory tests result of soil samples pertaining to Dhukwan Hydro-electric Project, Jhansi (U.P.)
(77)	84 TR (S_1-03)	Determination of silt factor of River bed material samples pertaining to Kosi Barrage Ramnagar.
(78)	84 TR (MTU_1-04)	Determination of silt factor of five nos. soil samples pertaining to Baghdi Gadhera, Irrigation division -Almora (U.K.).
(79)	84 TR (MTU_1-05)	Determination of silt factor of three nos. samples pertaining to Irrigation division Srinagar (Garhwal)
(80)	84 TR (MTU_1-06)	Determination of silt factor of 01 no. soil sample pertaining to River Ganga Triveni Ghat, Rishikesh Irrigation division- Dehradun.
(81)	84 TR (MTU_1-07)	Determination of silt factor of soil samples collected from various point pertaining to Kedarnath Irrigation division Rudraprayag
(82)	84 TR (MTU_1-08)	Determination of silt factor of 01 no. soil samples received from Senior Manager (Civil) NM&JS HEPS,SJVN Mori Uttarkashi.
(83)	84 TR (MTU_1-09)	Determination of silt factor of soil samples collected from various point pertaining to Kedarnath Irrigation division Rudraprayag
(84)	84 TR (MTU_1-10)	Determination of silt factor of soil samples pertaining to A.E.-I, Irrigation division Uttarkashi.
(85)	84 TR (MTU_1-11)	Determination of silt factor of disturbed soil samples pertaining to Irrigation division New Tehri
(86)	84 TR (MTU_1-12)	Determination of silt factor of disturbed soil samples pertaining to Irrigation division New Tehri
(87)	84 TR (MTU_1-13)	Determination of silt factor of three no. samples pertaining to A.E.-III Irrigation sub division Kotdwar.
(88)	84 TR (MTU_1-14)	Determination of silt factor of 09 no. soil samples received from Executive Engineer Irrigation division- Roorkee (U.K.).
(89)	84 TR (MTU_1-15)	Determination of silt factor of 01 no. soil sample pertaining to River Pinder Irrigation division - Chamoli.
(90)	84 TR (SRU_1-16)	Determine the soil classification and Direct Shear test of two soil sample received from Executive Engineer(C&M), MB-11,U.J.V.N. Ltd. Joshiyara , Uttarkashi (U.K.)

(c) SOIL RESEARCH UNIT - II

The Soil Research Unit - 2, comprises of two sub divisions viz. Chemical Laboratory (Sub division-I) and Soil Laboratory (Sub divison-2)

Chemical laboratory carries out various tests viz. chemical analysis of water samples for examining its suitability for use in Irrigation, drinking and Cement Concrete test purposes. Chemical analysis of Cement Mortar/Cement Concrete samples are tested to find out mix proportions of cement, sand & ballasts and various constituents of cement by Gravimetric method. Test for Alkali reactivity test of aggregate samples, silt contents in water samples and grain size distribution of silt samples are also conducted here.

Soil laboratory of this division with tests deals soil classification, determination of engineering properties of soil samples, field investigations for determination of bearing capacity of foundation soil and in-situ permeability test of soils.

Sl.No.	T R No.	Title of Test Report
(91)	84 TR(S_2-02)	Chemical analysis of P.P.C Cement sample.
(92)	84 TR (S_2-03)	Classification test result of soil samples.
(93)	84 TR (HRU_1-04)	Determination of Silt factor of soil Samples received from Executive Engineer, Irrigation Division, Chamoli.
(94)	84 TR (HRU_1-05)	Alkali Aggregate reactivity test of Aggregate samples.
(95)	84 TR (HRU_1-06)	Chemical Analysis of Cement Mortar Samples.
(96)	84 TR(S_2-07)	Chemical analysis of cement Mortar sample.
(97)	84 TR(S_2-08)	Chemical analysis of cement Mortar sample.
(98)	84 TR(S_2-09)	Chemical analysis of Cement sample
(99)	84 TR(S_2-10)	Alkali Aggregate reactivity test of Aggregate samples.
(100)	84 TR(S_2-11)	Alkali Aggregate reactivity test of Aggregate samples.

It was a privilege and pleasure to see this important station

J W Hilf, Chief (Designs)
USBR, Colorado

SECTION - E

(a) OFFICER IN-CHARGE DURING THE YEAR 2013-14

Chief Engineer (Design) & Director IRI, ROORKEE	Er. A.K.Dinkar
Superintending Engineer	
Research Circle	Er. N. K. Sharma
Hydraulics Circle	Dr. Subhash Mitra

HYDRAULIC RESEARCH UNIT- I

Research Officer	Er. S.K.Saha
Assistant Research Officer-I	Er. B.D. Joshi
Assistant Research Officer-II	Sh.Ram Swaroop
Assistant Research Officer-III	Sh. Sushil Kumar
Assistant Research Officer-IV	Sh. Surendra Mohan

HYDRAULIC RESEARCH UNIT - II

Research Officer	Er. Ajay Kumar
Assistant Research Officer-I	Sh. Ajay Kumar
Assistant Research Officer-II	Er. B.D Joshi
Assistant Research Officer- III	Sh. Surendra Kumar
Assistant Research Officer-IV	Sh. Ram Ashish

GROUND WATER RSEARCH UNIT - I

Research Officer	Er. Kapil Kumar
Assistant Research Officer-I	Sh. R.R. Mohan
Assistant Research Officer-III	Sh. Surendra Kumar

GROUND WATER RSEARCH UNIT - II

Executive Engineer	Er. Kapil Kumar
Assistant Research Officer-I	Sh. R.R. Mohan
Assistant Research Officer- II	Sh. Surendra Kumar

BASIC RESEARCH UNIT - I

Research Officer	Sh. Sushil Kumar
Assistant Research Officer- I	Sh. Sushil Kumar
Assistant Research Officer- II	Sh. Vinod Kumar
Assistant Research Officer- III & IV	Sh. Chhatter Singh

BASIC RESEARCH UNIT - II

Research Officer	Er. Ajay Kumar
Assistant Research Officer-I	Er. B.D. Joshi
Assistant Research Officer-II	Sh. Dheer Singh
Assistant Research Officer-III	Sh. Ram Swaroop
Assistant Research Officer- IV	Sh. Dheer Singh

MATERIAL TESTING UNIT - I

Executive Engineer	Sh. Bijendra Pal
Assistant Engineer- I & II	Sh. Bijendra Pal
Assistant Engineer- IV	Sh. Sukhvir Singh

MATERIAL TESTING UNIT - II

Executive Engineer	Sh. R.R. Mohan
Assistant Research Officer- II	Sh. R.R. Mohan
Assistant Research Officer-III	Sh. Ajay Kumar

SOIL RESEARCH UNIT - I

Research Officer	Sh. Dheer Singh
Assistant Research Officer- I	Sh. Kanwer Pal
Assistant Research Officer- III	Km. Sheela Rani
Assistant Research Officer- IV	Sh. Sukhvir Singh

SOIL RESEARCH UNIT - II

Research Officer	Sh. Sushil Kumar
Assistant Research Officer- I	Sh. Kishan Lal
Assistant Research Officer- II	Sh. Kishan Lal

ADMINISTRATIVE DIVISION

Executive Engineer	Er. Dixant
Assistant Engineer- I	Er. S.K. Mamgai
Assistant Engineer- II	Er. Jagpal Singh
Assistant Engineer-III	Er. Upendra
Assistant Engineer-IV	Er. S.C. Pant
Assistant Engineer-V	Er. L.M. Kudiyal

(b) PARTICIPATION IN HIGH LEVEL MEETING / SEMINAR/ WORKSHOP.

Sl. No.	Name of Seminar/ Symposium / Workshop / Training etc.	Place	Date	Name of Research Personnel who attended
1.	Conference on "Turbine Abrasion Protection & Reservoir Sedimentation Monitoring"	BIS, Manak havan, New Delhi	30 May, 2013	Er. S. K. Saha, Executive Engineer
2.	16th Meeting of WRDC	BIS, Manak havan, New Delhi	28 June, 2013	Er. S. K. Saha, Executive Engineer
3.	Meeting of Rihand Dam Joint Engineers Te am	Pipri, Sonbhadra (UP)	16 Aug, 2013	Er. S. K. Saha, Executive Engineer
4.	Meeting of "Rihand Dam Structural Behaviour Monitoring Committee"	Pipri, Sonbhadra (UP)	17-18 Aug, 2013	Er. S. K. Saha, Executive Engineer
5.	"All India Seminar on Conservation and Protection of underground water"	The Institution of Engineers (India), Dehradun	20-21 Sept, 2013	Er. A. K. Dinkar, CE Er. N. K. Sharma, SE Dr. Subhash Mitra, SE Er. Kapil Kumar EE
6.	"Conference on A dvancements in Water Modeling"	IIT Delhi	23-24 Sept, 2013	Er. S. K. Saha, Executive Engineer
7.	46th Meeting of "Gandak High Level Standing Committee"	Gorakhpur (UP)	23-26 Oct, 2013	Er. S. K. Saha, Executive Engineer
8.	"Workshop on Design Flood Issues"	CSMRS, New Delhi	19-20 Nov, 2013	Er. S. K. Saha, Executive Engineer
9.	15th Meeting of "Hydraulic Structures Instrumentation Section Committee" WRD 16	BIS, Manak havan, New Delhi	22 Nov, 2013	Er. S. K. Saha, Executive Engineer
10	"Workshop cum Awareness Building Programme on Ultra Low Head Hydro Potential" (Thursday),	Hotel Sarovar Portrico and HRS Bahadarabad	05 Dec, 2013	Er. S. K. Saha, Executive Engineer
11	International Geo - Techn ical Conference – 2013	IIT, Roorkee	22-24 Dec, 2013	Er. A. K. Dinkar, CE Er. N. K. Sharma, SE Dr. Subhash Mitra, SE Er. S. K. Saha, EE
12	15th Meeting of "Canals and Cross Drainage Works Sectional Committee, WRD 13"	BIS, Manak havan, New Delhi	03 March , 2014	Er. S. K. Saha, Executive Engineer
13	14th Meeting of "Hydraulic Gates & Valves Sectional Committee WRD 12 "	BIS, Manak havan, New Delhi	20 March, 2014	Er. S. K. Saha, Executive Engineer

(c) VISITORS

Sl.No.	Name / Designation & Address	Project	Date
1	Mr. Praveen Verma, A.G.M. Mr. Praveen Gupta, A.G.M. Mr. Surjeet Singh, Engineer	Naitwar Mori	04/04/2013
2	Mr. R. S. Varshney, Consultant L & T Mr. Sanchit Kumar, A.M., L & T Mr. A. N. Bhargav, Consultant L & T	Lata-Tapovan	06/04/2013
3	Mr. R.A. Oak, (Hydraulic Expert), Puna Mr. Jitendra Singh, A.G.M., RITES Ltd. Mr. Vikalp Pandey, G.T., RITES Ltd.	Bogibil	15&16/04/2013
4	Mr. G.S. Rayudu, Director, GVK Mr. Ratan Kumar Vakkalgadda, Manager, GVK Mr. Sanchit Kumar, Engineer, L&T EDRC	Ratle HEP	17/04/2013
5	Mr. Shailendra Chauhan Mr. Dinesh Purushe, HCC Mr. Ganesh, HCC Mr. Vijay Kumar Kopta, HCC Mr. Pranjeet Chakravarti, HCC	Tehri PSP	25/04/2013
6	Mr. A.K. Dinkar, Director IRI, Roorkee Mr. N.K Sharma, SE, Hydraulics	HRS Bahadrabad	29/04/2013
7	Mr. Jitendra Singh, A.G.M., RITES Ltd. Mr. Vikalp Pandey, G.T., RITES Ltd.	Bogibil	20/05/2013
8	Mr. Jitendra Singh, A.G.M., RITES Ltd Mr. Vikalp Pandey, G.T., RITES Ltd.	Bogibil	31/05/2013
9	Mr. Devid Gamraun Elish, L&T Mr. A.P. Singh, Head (Civil), L&T Mr. Sanchit Kumar, Engineer, L&T	Ratle HEP	04/06/2013
10	Mr. Amar Pal Singh, A.G.M. L & T Mr. Sanchit Kumar, A.M., L & T	Bogibil	04/06/2013
11	Mr. Vikalp Pandey, G.T., RITES Ltd.	Bogibil	07/06/2013
12	Mr. O.P. Thakur, Manager, S.J.V.N.L. Shimla Mr. Surjeet Singh, Engineer, S.J.V.N.L. Shimla	Bogibil	11/06/2013
13	Mr. M.T. Desaraju, G.M., Moser Baer Mr. Vivek Singh, AGM, Moser Baer Mr. Chetan Sharma, AM, Moser Baer	Seli HEP	12/08/2013
14	Mr. M.T. Desaraju, G.M., Moser Baer Mr. Vivek Singh, AGM, Moser Baer Mr. Chetan Sharma, AM, Moser Baer Mr. Ratna Kumar, Asstt. Principal Engineer, Moser Baer	Seli HEP	13/09/2013
15	Mr. Om Jangid, A.M., L & T Mr. R. S. Varshney, Consultant L & T Mr. Sanchit Kumar, A.M., L & T Mr. P. S. Rawat, D.G.M. N. T.P.C. Mr. Amar Singh, N. T.P.C.	Bogibil	23&24/09/2013

16	Mr. Vstul Jain, DGM, THDC Mr. Natrajan Krishna, Manager, THDC Mr. M.K. Rai, Sr. Manager, THDC Mr. Ashish Kumar, Engineer, THDC Mr. H.N.R. Kerersker, HCC, Mumbai Mr. Shesh Mani Sonkar, Engineer, HCC, Mumbai Mr. Srijit Kumar, ALSTOM Mr. N.K. Sharma, SE, Hydraulics Mr. A.C. Pandey, Consultant, HCC Mumbai	Tehri PSP	25/09/2013
17	Mr. Saurabh Joshi, Engineer, S.J.V.N.L. Shimla	Bogibil	13/12/2013
18	Mr. Samay Singh, Consultant WAPCOS Mr. Prakash Chandra, Consultant WAPCOS Mr. Gurdeep Singh, Engineer WAPCOS Mr. Om Jangid, A.M., L & T	Bogibil	23/12/2013
19	Mr. O.P. Thakur, Manager, S.J.V.N.L. Shimla Mr. Surjeet Singh, Engineer, S.J.V.N.L. Shimla	Bogibil	16/01/2014
20	Mr. Karpaga Haseen, HCC, Mumabi	Tehri PSP	18/02/2014
21	Mr. P.B. Deolalikar, Advisor L&T Mr. A.P. Singh, Head (Civil), L&T Mr. Rajeev Kumar, Engineer L&T Mr. Ravindra Shahu, Enginerr, L&T Mr. Satyajeet Sinha, Asstt. Engineer L&T	Ratle HEP	19/02/2014
22	Mr. Samay Singh, Consultant WAPCOS Mr. Prakash Chandra, Consultant WAPCOS Mr. Om Jangid, A.M., L & T Mr. P. S. Rawat, D.G.M. N. T.P.C., Noida. Mr. Shanmukhi Gupta, DCDE, NTPC, Noida.	Bogibil	24&25/02/2014
23	Mr. Atul Jain, DGM, THDC, Rishikesh Mr. Shesh Mani Sonkar, Engineer, HCC, Mumbai	Tehri PSP	11/03/2014

Very interesting and useful experiments are in progress. The Director and staff deserve congratulations for their energetic and original approach in solving practical problems.

Dr K L Rao
Union Irrigation Minister

(d) VOCATIONAL TRAININGS IN IRI, ROORKEE.

Engineering Students of following Institutes took part as group trainees during 2013-14

Sl. No.	Name of Institution	Period (In Weeks)
B.Tech (Civil Engineering)		
1	College of Technology, G.B.Pant University of Agriculture & Technology Pantnagar, Uttarakhand	04
2	College of Engineering Roorkee, Roorkee, Haridwar.	06
3	G.B. Pant Engineering College, Ghurdauri, Pauri Garhwal, Uttarakahnd	06
4	Maharishi Ved Vyas Engineering College, Jagadhari, Yamuna Nagar, (Haryana)	06
5	Bishambar Sahai Group of Institutes, Roorkee	06
6	Shivalik College of Engg. ,Sihniwale, Shimla Road, Dehradun	06
7	THDC Institute of Hydro Power Engineering & Technology, Bhagirathipuram, Tehri	04
8	Phonics Group of Institutes, Roorkee	04
9	PEC University of Technology, Chandigarh	04
10	K.L.S. Institutes of Engg. & Technology, Bijnor (U.P)	04
11	Hindustan Institutes of Technology & Management, Dheen, Ambala	06
12	Graphic Era University Dehradun, Uttarakahnd	04
Diploma (Civil Engineering)		
13	Shakambhari Institute of Higher Education & Technology, Roorkee	02
14	K.L. Polytechnic Roorkee, Uttarakhand	04
15	Uttaratech Polytechnic, Dhanauri, Roorkee, Uttarakahnd	04
16	College of Advanced Technology, Roorkee, Uttarakhand	04
17	OM Institute of Technology Roorkee, Roorkee Uttarakhand	04
18	Swami Darshnanand Institute of Management & Technology, Gurkul Mahavidhyalya, Jwalapur, Haridwar	06
19	Roorkee College of Polotechnic, Kisahanpur Haridwar Uttarakhand.	04
20	S.P.I.M. College Bilaspur, Muzaffarnagar (U.P.)	04
21	B.S.M. College of Polytechnic, Roorkee, Uttarakhand	04
22	Govt. Polytechnic Dehradun Shimla Bypass Road, Pithuwala, Dehradun	04
23	V.I.E.T, South Civil Lines, Circular Road, Muzaffarnagar (U.P.)	04
24	Motherhood Institute of Management & Technology, Roorkee, Uttarakhand	04
25	Ramanand Institute of Pharmacy & Management, Jwalapur, Haridwar	04
26	Maa Sharda Institute for Polytechnic, Jagadhari (Haryana)	02
27	Blue Mountains Group of Colleges, Govind Nagar, Sahastra Dhara Road, Dehradun	02

The Institute has excellent facilities and an asset to the Nation

Prof. Bharat Singh
Former Vice Chancellor, University of Roorkee

(e) Time Schedule of Different Lab. Tests Carried out at IRI Roorkee

(i) Soil Mechanics

Sl.No.	Name of the Test	Days
1	Mechanical Analysis (Screen/Sieve/Hydrometer/Liquid Limti	10
2	Specific Gravity	1
3	Natural Moisture Content and Density	1
4	Compaction test	3
5	Maximum and Minimum density of cohesionless soil	1
6	Consolidation test (At Saturation)	15
7	Permeability test (At Saturation)	2
8	Direct shear test (60x60x20 mm)	4
9	Direct shear test (300x300x150 mm)	6
10	Unconfined compression test	1
11	Triaxial shear test (37.5m m Dia x 75mm high) { At OMC/NMC & Saturation }	4 - 8
12	Triaxial Compression test (100mm Dia x 200mm high) { At OMC/NMC & Saturation }	4 - 8
13	Triaxial Shear Test (200mm Dia x 400 mm) { At OMC/NMC & Saturation }	10-15
14	Large size permeability test (50 cm dia)	2
15	Dispersibilty test	10

(ii) Chemical Analysis of Cement Mortar/Water Sample/Soil Sample etc.

Sl.No.	Name of the Test	Days
1	Chemical Analysis of Cement Sample	23
2	Chemical Analysis of Cement Mortar /Concrete Sample	14
3	Chemical Analysis of Water Sample	14
4	Alkali Aggregate Reacting test of Alkali Aggregate Sample	14
5	Silt content(mg/liter) in Water Sample	3
6	Determination of grain size distribution of Silt Sample	3

(iii) Rock Mechanics

Sl.No.	Laboratory Test	Days
1	Modulus of Elasticity and Poission Ratio	2 – 3
2	Unconfined Compressive Strength on Rock core Specimen	2 – 3
3	Shear Parameters ‘C’ and ‘Ø’	3
4	Point Load Strength Index/Tensile Strength	1
5	Water Absorption/Porosity/Density	2 – 3
6	Cutting, Grinding and Polishing of rock cubes	2
7	Drilling, Cutting, Grinding and Polishing of rock core	2
8	Co-efficient of Permeability	2 – 3
9	Abrasion Test (by Dorry’s Method)	1

(iv) Material Testing

Sl.No.	Name of the Test	Days
[A] Concrete		
1	(i) Cement Concrete Mix Design (28 days basis)	70
	(ii) Cement Concrete Mix Design (90 days basis)	160
	(iii) Cement Concrete Mix Design (180 days basis)	250
	(iv) Roller Compacted concrete Mix Design	75
2	Compressive Strength of Concrete cubes as per requirement	1-28
3	Flexural Strength of Concrete beams as per requirement	1-28
[B] Bricks/ Brick Tiles		
1	Warpage	1
2	Water absorption/ Flexural Strength (only for Tiles)/ Efflorescence	3
3	Compressive Strength	6
[C] Steel/ Welded Joints (Upto 25mm dia)		
1	Tensile Strength (9 bars)	1
[D] Fine Aggregate		
1	Sieve Analysis, Unit Weight	1
2	Material finer than 75 microns	2
3	Specific gravity & Water absorption/ Organic Impurities	3
4	Soundness	6
[E] Coarse Aggregate		
1	Sieve Analysis/ Unit Weight/ Impact Value/ Crushing Value/ Abrasion Value/ Flakiness/ Elongation Index	1
2	Material finer than 75 microns	2
3	Specific gravity & Water absorption/ Organic Impurities	3
4	Soundness	6
[F] Cement		
1	Standard Consistency/ Setting time/ Fineness (Specific Surface)/ Specific Gravity	1
2	Soundness	2
3	Compressive Strength	28
[G] Pozzolana		
1	Standard Consistency/ Setting time/ Fineness (Specific Surface)/ Specific Gravity	1
2	Soundness	2
3	Compressive Strength	28-90
4	Lime Reactivity Test	28
[H] Abrasion Test		
1	By Sand Blast Method	2
2	By High Velocity Water Jet Method	3

(f) PICTORIAL VIEW OF R&D ACTIVITIES

A Panoramic View of BAHADRABAD from Google Earth

A View of Right Bank Shaft Spillway of Tehri Dam Site

EHDA Model of Jorthang Barrage (Sikkim) showing experimental set-up in Ground Water Laboratory

Models of Measurement of Discharge & Seepage Laboratory Losses using Tracer Technique in Isotope Laboratory

Meteorological Observatory Situated at Bahadrabad

Abrasion Testing Machine in Material Testing Laboratory

Visitors at Hydraulic Research Station, Bahadrabad (Hardwar)

Model Study for Tehri Pumped Storage Plant, (Uttarakhand)

Model Study for Ratle Hydro Electric Project, Kishtwar (J&K)

Organisational Setup of Irrigation Research Institute

Chief Engineer & Director

- **Superintending Engineer Hydraulic Circle**
  - R.O. H-1 Unit
  - R.O. H-2 Unit
  - R.O. B-2 Unit
- **Superintending Engineer Research Circle**
  - R.O. Soil-1 Unit
  - E.E. Soil-2 Unit
  - E.E. MT-1 Unit
  - E.E. MT-2 Unit
  - R.O. B-1 Unit
  - R.O. GW-1 Unit
  - E.E. GW-2 Unit
  - E.E. Adm. Unit

Assistant Engineer/Assistant Research Officer -32

Field Research Station, Bahadrabad

R & D Activities At a Glance

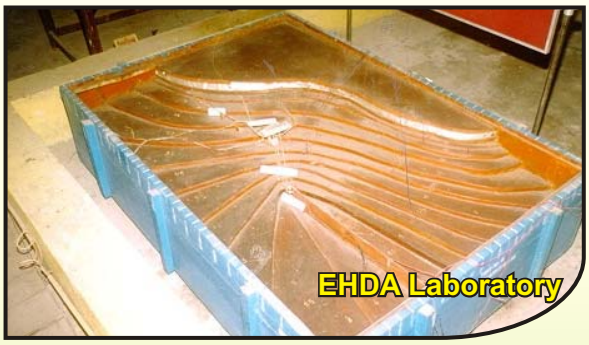

Meteorological Observatory


River Model


Water Quality


Material Testing Laboratory


Material Testing Laboratory


EHDA Laboratory

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SAVE WATER TO SAVE EARTH

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