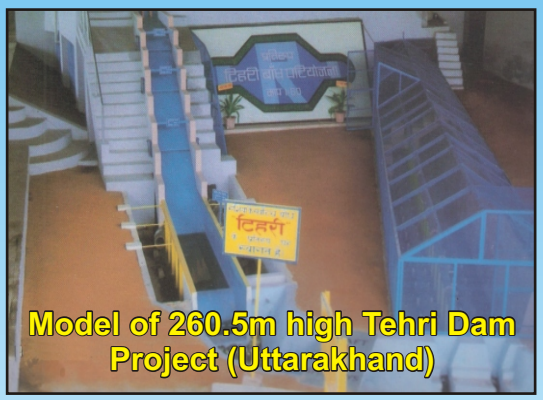

Model of 260.5m high Tehri Dam Project (Uttarakhand)

Model of Baglihar Project (J & K)

Model of Diversion Tunnel of Dibbon H.E.P.(Arunachal Pradesh)

Model of Bogibil Rail cum Road Bridge (Assam)

Model of Desilting Chamber

Technical Memorandum No. 83
(For Official Use Only)

उत्तराखंड शासन

Annual Report 2012-13

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

Website : www.iriroorkee.com
e-mail : info@iriroorkee.com
Phone: 01332 - 265174/257501
Fax :01332 - 262487

May, 2013

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.
  - Determination of Geohydrological Parameters by Radio Active Tracer Technique.
  - Artificial Recharging
- Sedimentation Studies
  - Capacity and Life of Reservoirs.
  - Sediment Transport in 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.

Editorial Committee

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Annual Report
2012-13

An ISO 9001:2008 Certified Organization

Irrigation Research Institute
Roorkee - 247 667(Uttarakhand)

May, 2013

विजय बहुगुणा

मुख्यमंत्री, उत्तराखण्ड

उत्तराखण्ड सचिवालय
देहरादून - 248 001
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0135-2650433
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उत्तराखण्ड सरकार

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फैक्स : (0135)–2666308 (का.)
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सुभाष कुमार
Subhash Kumar

मुख्य सचिव
Chief Secretary

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Uttarakhand Secretariat
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0135-2712200
Fax : 0135-2712500

Dated : May 08, 2013

Message

I am happy to know that Irrigation Research Institute, Roorkee is publishing its 83rd Annual Report highlighting its achievement during the year 2012-13.

IRI Roorkee is a premier institution in the field of Hydraulic Modeling, Geotechnical Testing, Ground Water Studies, Flood Protection Works, Bridge Siting and Testing of materials for engineering use. I understand that IRI Roorkee has been associated with prestigious projects like Hasan Dam (Republic of Yeman), Nyabarango Hydroelectric Project, Rawanda (Africa), Upper Marsyangdi Hydroelectric Project (Nepal), Baglihar Hydroelectric Project (J&K, India/Pakistan), Rangit Hydroelectric Project (Sikkim), Teesta Hydroelectric Project (Sikkim), Rail-cum-Road Bridge across river Brahmputra at Bogibil (Assam), Tehri Dam (Uttarakhand) etc.

I am happy to learn that during the year 2012-13, IRI Roorkee has achieved an ISO 9001-2008 Certification and has undertaken hydraulic studies for various Hydroelectric Projects like Teesta Hydroelectric Project (Sikkim), Ratle Hydroelectric Project (J&K), Vishnugad-Pipalkoti Hydroelectric Project (Uttarakhand), Myar HEP (HP), Naitwar Mori HEP (Uttarakhand), Lata Tapovan (Uttarakhand) etc. Ground water studies for two districts of Haryana were undertaken. Thirty five research reports were submitted and four research papers by engineers of IRI Roorkee have been published which speaks volume of its contribution in Research and Development. I compliment engineers, scientists and staff of the institute for their outstanding achievements and hard work.

I wish all success for the publication of this report.

(Subhash Kumar)
Chief Secretary

Kunal Sharma
Secretary

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D.O. No. 28/PS/Secy., Irri./2013
Govt of Uttarakhand
Secretary, Irrigation
Dehradun
Date : 02 May, 2013

Message

It is a matter of great pleasure that Irrigation Research Institute, Roorkee is publishing its 83rd Annual Report which contains its R&D activities carried out during the year 2012-13.

IRI Roorkee is known for its significant contribution in the field of R&D activities related to Hydraulic Modeling 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 Dam (Uttarakhand), Vishnu Prayag H.E. Project, Chamoli (Uttarakhand), Baglihar H.E. Joint Project of India & Pakistan (J&K), Hasan Dam (Republic of Yeman) Upper Marsyangdi Hydroelectric Project (Nepal), Nyabarango Hydroelectric Project Rawanda (Africa), Rangit Hydroelectric Project (Sikkim). Myar H.E. Project (Himachal Predesh), Lower Rajghat Canal Project (U.P.), Natpha Jhakri Hydro-Electric Project (H.P) Polavaram Project (Andrha Pradesh).

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 2012-13.

(Kunal Sharma)
Secretary Irrigation

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 83rd annual report highlighting its technical achievements during the year 2012-13.

IRI, Roorkee is a very old and premier Institute in the field of Hydraulic Modeling and Testing of Engineering Materials. IRI Roorkee was initially established as a research unit in 1928 at Lucknow and was 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 2012-13, the Institute has taken up big leap in undertaking R&D activities of many projects like Hasan Dam Project (Republic of Yemen), Upper Marsyangdi H.E. Project (Nepal), Vishnugad Pipalkoti H.E. Project (Uttarakhand), Rangit H.E. Project (Sikkim), Teesta H.E. Project (Sikkim), Ratle H.E. Project (J&K), Bogibil Bridge across river Brahmaputra (Assam), Basantpur/Kalma/Sheorinarayan Barrages across Mahanadi river (Chattisgarh) and flood protection work for Golf Course Panchkula (Haryana) etc.

During the year, Institute had achieved an ISO 9001 : 2008 Certification, 35 research reports and 114 Test Reports were submitted. Four research papers by engineers of the Institute were published 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 2012-13 & 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 2012-13.

(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 83rd annual report of IRI, Roorkee for the year 2012-13 giving details of R&D activities carried out during the year. In 2012-13, 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 Research Station of IRI, Roorkee located at Bahadrabad has conducted model studies of small and large hydroelectric projects and flood protection works viz Vishnugad Pipalkoti H.E. Project (Uttarakhand), Rangit H.E. Project (Sikkim), Teesta H.E. Project (Sikkim), Ratle H.E. Project (J&K), Upper Marsyangdi H.E. Project (Nepal), Hasan Dam Project (Republic of Yemen), Bogibil Bridge across river Brahmaputra (Assam), Basantpur/Kalma/Sheorinarayan Barrages across Mahanadi river (Chattisgarh) and flood protection work for Golf Course Panchkula (Haryana) etc.

Some important activities and achievements of the Institute during 2012-13 are mentioned below:

- Getting an ISO: 9001-2008 Certification for IRI.
- Initiative taken for the model studies of Tehri Pump Storage Plant (TPSP).
- Consultancy services to the Haryana State on Ground Water Recharging Studies under-taken for the first time in the Institute.
- Publication of technical research papers (4Nos.), research reports (35Nos.) and test reports (114 Nos.) for various projects of Uttarakhand & other States.
- Preparation of working manual on hydraulic model studies.

I appreciate the remarkable efforts adopted by 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 take this opportunity to thank research personnels, engineers and staff who are working hard and are ready to undertake upcoming challenges. In the last, I extend a sincere note of appreciation to the officers and support staff involved in compilation and editing of the manuscript of this report well within time.

Jai Hind

(A. K. Dinkar)

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List of Publications, Research Reports & Technical/Research Papers

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Research Report
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General Information

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).

(c) Major Studies Carried Out During 2012-13

- Hydraulic Model Study for Main Dam Concrete Spillway of Hassan Dam Project (Republic of Yemen)
- Model Studies for Reservoir Sedimentation and Flushing of Upper Marsyangdi-2 HEP (Nepal)
- Hydraulic Model Study on scour around piers (A Basic Research Study).
- Model Study for Protection of Golf Course, Sector - 3, Panchkula (Haryana)
- Hydraulic Model Studies of Ratle H. E. Project (Jammu & Kashmir)
- 2D- Model studies for Mironi Barrage, Basantpur Barrage, Kalma Barrage, Sheorinarayan Barrage and Saradih Barrage across Mahanadi River in Janjgir (Chattisgarh)
- Hydraulic Model Study for Vishnugad Pipalkoti HEP (Uttarakhand)
- Compilation and Analysis of Observations Recorded at Meteorological Observatory, Hydraulic Division-II, Bahadrabad (Uttarakhand)
- Model Studies for Protection of South Guide Bund of Bogibil Bridge on river Brahmaputra (Assam)
- Model Studies for Desilting Chamber Rangit (Stage-IV) H.E. Project (Sikkim)
- Model Studies for Uniform Discharge Distribution through Spillway of Rangit H.E. Project (Sikkim)
- Model Studies for Desilting Chamber of Teesta (Stage-VI) H.E.P (Sikkim)
- Capacity Survey of Pili Reservoir (Uttar Pradesh).
- Feasibility report on Artificial Ground Water Recharge for Mahendrgarh district (Haryana).
- Determination of Elastic and Shear Properties of Foundation Rock at Kosi Barrage site, Almora (Uttarakhand)
- Determination of In-Situ Engineering Properties for proposed Rohin Barrage-3, Maharajganj (Uttar Pradesh)

(d) Technical/Research Papers Published During 2012-13

(i) Sediment Deposition Study of the Reservoir for Rihand Dam Project – A Case Study.

Authors:

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

(Paper published in Seminar on Sedimentation in Reservoirs (21st December 2012) Organized by Water Resources Department, Bureau of Indian Standards, New Delhi).

(ii) Cavitation Studies of Chute Spillway for Asia's Highest Dam – A Case Study.

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 Kumar Sharma, Executive Engineer, IRI, Roorkee.

(Paper published in Seminar on Dams and Spillways in Himalayan Regions (30th November 2012), Ogranized by Water Resources Department Bureau of Indian Standards, New Delhi).

(iii) Authenticity of Different Formulae Used For the Flow Measurement in Open Channel by Sharp-Crested Weir.

Authors:

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

(Paper published in Water and Energy Journal, Volume 69, No. 7, July 2012, Central Board of Irrigation and Power (CBI&P), New Delhi).

(iv) Use of Model Studies for Safe & Economical Design of Hydraulic Structure.

Authors:

- Suresh Chandra Sharma, Chief Engineer (Design) & Director IRI, Roorkee.
- Dr. Subhash Mitra, Superintending Engineer, IDO, Roorkee.
- Shankar Kumar Saha, Executive Engineer, IRI, Roorkee.

(Paper published in Bhartiya Vaigyanik Evam Audyogik Anusandhan Patrika, Year 20, No. 1, June 2012, published by Council of Scientific & Industrial Research (CSIR), New Delhi).

(e) PUBLICATIONS

The following are the types of publications which were issued during the year 2012-13

(i) Annual Report — Annual Report for the year 2011-12 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 2012-13, four Technical Papers were published in different journals/ seminars and a total number of thirty - five 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 2012-13, 114 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) COORDINATION 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 Ea rthquake 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 DIVISION - I

Hydraulic Division–I, essentially 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)	83 RR (H_1-01)	A Basic Model Study on scour around piers
(2)	83 RR (H_1-02)	Protection of Golf Course, Sector – 3, Panchkula (Haryana)
(3)	83 RR (H_1-03)	Hydraulic Model Studies of Ratle H. E. Project (Jammu & Kashmir)
(4)	83 RR (H_1-04)	A Report on Hydraulic Model Studies of Ratle H. E. Project (Jammu & Kashmir)
(5)	83 RR (H_1-05)	A Research Report on Hydraulic Model Studies of Ratle H.E.P. (Distt. Kishtwar, J & K)

(ii) HYDRAULIC DIVISION-II

Hydraulic Division-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
(6)	83 RR (H -01)	Annual Report of Hydraulic Division-II
(7)	83 RR (H_2-02)	Model studies for surge shaft of Rampur Hydro Electric Project (Himachal Pradesh).
(8)	83 RR (H_2-03)	Model Study for Upper Marsyangdi-2 HEP (Nepal)
(9)	83 RR (H_2-04)	2D- Model studies for Mironi Barrage across Mahanadi River, Janjgir Champa District (Chattisgarh)
(10)	83 RR (H_2-05)	2D-Model Studies for Basantpur Barrage across Mahanadi River in Janjgir-Champa District, (Chattisgarh)
(11)	83 RR (H_2-06)	2D-Model Studies for Kalma Barrage across Mahanadi River in Janjgir - Champa District, (Chattisgarh)
(12)	83 RR (H_2-07)	2D-Model Studies for Sheorinarayan Barrage across Mahanadi River in Janjgir- Champa District, (Chattisgarh)
(13)	83 RR (H_2-08)	2D-Model Studies for Saradih Barrage across Mahanadi River in Janjgir - Champa District, (Chattisgarh)
(14)	83 RR (H_2-09)	Hydraulic Model Studies for Reservoir Sedimentation and Flushing of Upper Marsyangdi-2 HEP (Nepal)
(15)	83 RR (H_2-10)	Further Model Study for Vishnugad Pipalkoti HEP (Uttarakhand)
(16)	83 RR (H_2-11)	Model Study for Main Dam Concrete Spillway of Hassan Dam Project, (Republic of Yemen)
(17)	83 RR (H_2-12)	Compilation and Analysis of Observations Recorded at Meteorological Observatory, Hydraulic Division-II, Bahadrabad (Uttarakhand)

(iii) HYDRAULIC DIVISION-III

The division 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
(18)	83 RR(H_3-01)	Annual Report of Hydraulic Division-III
(19)	83 RR (H_3-02)	Model Studies for Protection of South Guide Bund of Bogibil Bridge across River Brahmaputra (Assam).
(20)	83 RR (H_3-03)	Model Studies for Desilting Chamber of Rangit (Stage-IV) Hydro Electric Project (Sikkim).
(21)	83 RR(H_3-04)	Model Studies for Uniform Discharge Distribution through Spillway of Rangit (Stage-IV) Hydro Electric Project (Sikkim).
(22)	83 RR(H_3-05)	Model Studies for Desilting Chamber of Teesta (Stage-VI) Hydro Electric Project (Sikkim).

(iv) HYDRAULIC DIVISION-IV

Hydraulic Division-IV specifically dealswith the capacity survey and sedimentation studies of different reservoirs in Uttarakhand and other States. Important studies carried out by this division during the year are as follows:

(i) Capacity survey of Matatila Dam Reservoir (Uttar Pradesh).
(ii) Capacity Survey of Pili Reservoir (Uttar Pradesh).

Sl. No.	R.R. No.	TITLE OF REPORT
(23)	83 RR (H_4 - 01)	Capacity Survey of Pili Reservoir (Uttar Pradesh).

(V) GROUND WATER DIVISION-I

Ground Water Division-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
(24)	83 RR (GW_1-01)	Annual Report Ground Water Division-I

(vi) GROUND WATER DIVISION-II

This Division 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
(25)	83 RR (GW_2-01)	Annual Report Ground Water Division–2.
(26)	83 RR (GW_2-02)	Hydraulic Performance of Pressure Release Valves.
(27)	83 RR (GW_2-03)	Feasibility report of Distt. Mahendrgarh (Haryana) for Artificial Ground Water Recharge.

(Vii) BASIC DIVISION

Basic Division 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 personnels.

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
(28)	83 RR (B - 01)	Annual Report of Basic Division
(29)	83 RR(B - 02)	Digital Map of Uttarakhand with location of Dams, Barrages and Weir on the rivers and their features.

(viii) MATERIAL TESTING DIVISION - I

The Material Testing Division- 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 division 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.

(ix) MATERIAL TESTING DIVISION – II

This division 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
(30)	83 RR (MT_2-01)	Annual Report Material Testing Division-2.
(31)	83 RR (MT_2-02)	Analysis of pull-out test results for proposed revision of IS code: 11309-1985 (reaffirmed in April, 2011)

(x) SOIL DIVISION – I

The Soil Research Division-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 behaviour 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
(32)	83 RR (S_1-01)	Annual Report Soil Division -1
(33)	83 RR (S_1-03)	Determination of Elastic and Shear Properties of Foundation Rock at the site of Proposed Kosi Barrage Almora Uttarakhand
(34)	83 RR (S_1-07)	Determination of Bearing Capacity for the Foundation of proposed Rohin Barrage-3, Maharajganj U.P
(35)	83 RR (S_1 -09)	Determination of in Place Permeability by Auger Head Test Method at The site of proposed Rohin Barrage-3, Maharajganj U.P.

(b) TECHNICAL/RESEARCH PAPERS

Sl. No.	Title of Paper	Authors Name	Paper Published in
1	Sediment Deposition Study of the Reservoir for Rihand Dam Project – A Case Study	Aditya Kumar Dinkar, Dr. Subhash Mitra, Shankar Kumar Saha	Seminar on Sedimentation in Reservoirs (21st December 2012) Bureau of Indian Standards, New Delhi.
2	Cavitation Studies of Chute Spillway for Asia's Highest Dam – A Case Study	Aditya Kumar Dinkar, Dr. Subhash Mitra, Shankar Kumar Saha, Ajay Kumar Sharma	Seminar on Dams and Spillways in Himalayan Regions (30th November 2012) BIS, New delhi.
3	Authenticity of Different Formulae Used For the Flow Measurement in Open Channel by Sharp-Crested Weir	Aditya Kumar Dinkar, Dr. Subhash Mitra, Shankar Kumar Saha	Water and Energy Journal, Volume 69, No. 7, July 2012, CBI&P, New Delhi.
4	Use of Model Studies for Safe & Economical Design of Hydraulic Structure.	Suresh Chandra Sharma, Dr. Subhash Mitra, Shankar Kumar Saha	Bhartiya Vaigyanik Evam Audyogik Anusandhan Patrika, Year 20, No. 1, June 2012, CSIR, New Delhi

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

(a) RESEARCH REPORTS

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

(i) HYDRAULIC DIVISION – I

(1) Hydraulic Model Study on scour around piers - A Basic Research Study.

83RR (H_1-01)

The important findings of this basic study for the estimation of scour around piers are as follows:

- Maximum scour depths around piers observed in the model were found very close to the values as these of computed on the basis of formulae developed by English, Laursen & Toch, Shen & Scheinder, Liu, Chang & Skinner and RDSO.
- Among various scour depths around piers computed from formula proposed by Laursen & Toch were found almost similar as observed in the model.

View of scour around pier at 90^0 flow for f = 8.222

View of scour around pier at 90^0 flow for f = 9.297

- It is observed that the effect of angle of attack influences the scour quite significantly . It is also seen in the model that scour depth around piers increases with the increase in depth of flow, velocity of flow, Froude/Reynold Numbers.

(2) Model Study for Protection of Golf Course, Sector – 3, Panchkula (Haryana)

83RR (H_1-02)

The Hydraulic Physical Model study for the protection of Golf Course, Sector-3,

Panchkula located on the right bank of river Ghaggar in the down stream of old Panchkula bridge was referred to I.R.I, Roorkee by Executive Engineer, Div-1, HUDA, Panchkula (Haryana).A distorted physical model on a horizontal scale 1:100 and vertical scale 1:40 (vertical exaggeration 2.5 & discharge scale 1:25300) has been constructed to conduct the hydraulic model study. The retaining wall already constructed on the left of river Ghaggar for the protection of Sector-22, Panchkula was also incorporated in the model.

The hydraulic model tests, revealed that the maximum velocities along left bank of the order of 18 m/sec and along right bank of the order of 15 m/sec were observed at design flood 4036 cumec and 2018 cumec respectively. It was also observed that at design flood the retaining wall constructed for the protection of sector – 22 along left bank in front of Golf Course was overtopped in some reaches.

(3 to 5) Hydraulic Model Studies of Ratle H. E. P. (Distt. Kishtwar, Jammu & Kashmir)

83RR(H_1-03,04, 05)

Hydraulic Physical Model studies were conducted with a geometrical similar 3D model on 1:55 scale (discharge scale 1:22434) for the adequacy of dam spillway & location of power intake, etc. of Ratle Hydro Electric Project, Distt. Kishtwar, Jammu and Kashmir. After model studies it was found that the waterway of dam having 5 sluice bays of

10.75m (w) x 14.20m (h) called as lower level spillway and one no. upper level spillway of same width provided for passing PMF was found marginally less at FRL under emergency condition. Formation of Vortices was observed at FRL in front of bays of lower level spillway. No any formations of vortices or rotational flow were observed in front of power intake. However, detailed study of power intake shall be carried out in the part model (scale 1:20). A height of 13.00 m + freeboard parallel to the surface of spillway of the divide wall is found sufficient. To avoid or minimize these variations of water level and negative pressure along abutment of rightmost bay of lower level spillway, similar expansion along the abutment as that of left pier/divide wall is proposed. To eliminate striking of trajectory at left bank of the river divide wall is proposed.

(ii) HYDRAULIC DIVISION – II

(6) Annual Report of Hydraulic Div.-II

83RR (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 has been conducted during 2011-12.

(7) Model studies for surge shaft of Rampur Hydro Electric Project (HP)

83RR (H_2-02)

Hydraulic model studies were conducted on a geometrically similar model built to scale 1:50 for surge shaft and multifunction of Rampur Hydro-Electric Project (412 MW)-Himachal Pradesh. The tests conducted on the model indicate that the flow conditions in the surge tank under inflow and outflow conditions were satisfactory. The observed pressures all around the orifice profile, HRT and penstock were found positive. The

circular orifice of 6.0 m diameter having profile radius of 0.25 m and 0.10 m at its upper and lower edges gave discharge coefficients (Cd) of the order of 0.696 and 0.814, with closed gate grooves, under inflow and outflow conditions respectively. While discharge coefficients of 0.651 and 0.750 were observed, with opened gate grooves, under inflow and outflow conditions respectively. Under steady state condition,

with design discharge of 383.88 cumec with surge tank water level of 997.08 and tailpool water level of 1010.0 m, Maximum pressure of the order of 61.60 m was observed at piezo point no.11 and 12 respectively.

(8) An Interim Report on Model Study for Upper Marsyangdi-2 HEP, Nepal.

83RR (H_2-03)

Model studies were conducted on the comprehensive physical model of upper Marsyandi-2 H.E.P, Nepal constructed on a geometrically similar scale of 1:40 after incorporating the ground surface profile and location of various components of project according to the latest data supplied by GMR Consulting Services Pvt. Ltd. The discharging capacity of the diversion tunnel was observed as 430.0 cumec at full reservoir level of 1702.00 m and no sub-atmospheric pressure was developed in the diversion tunnel. The provision of Waterway was observed to be adequate as the discharge of 3711 cumec passed safely through the spillways at a reservoir level 1695 m with all the three bays in operation. The same discharge passes through a two bays and diversion tunnel at

reservoir level of 1704.00 m. The sill of power intake was found to be suitably located at El. 1682.0 m so as to provide the minimum submergence required as per IS:9761-1995 (clause 5.2.2) and Gordon's criteria. No vortex formation was observed at any reservoir level at the mouth of intake. Also, no sub-atmospheric pressure was found to be developed in the intake and feeder tunnel to desilting tank.

(9) 2-D Model studies for Mironi Barrage across Mahandi River, Janjgir Champa District (Chattisgarh).

83RR (H_2-04)

Model studies were conducted for Mironi barrage, proposed to be constructed across Mahanadi River in Chattisgarh, on geometrically similar 2D-model built in a flume to the scale 1:35. Observations from the hydraulic tests indicated that the

proposed clear water way of 972 m with

barrage crest at El. 203.00 m was observed to be adequate to pass the design discharge of 37000 cumec at 216.40 m instead of 216.317 m (HFL) with all bays fully opened. Coefficient of discharge for barrage bays was worked out to be 0.760 for a discharge of 37000 cumec. No development of sub-atmospheric pressure was observed on crest and stilling basin. The proposed 28.0 m long stilling basin at 201.5 m is sufficient to dissipate the flow energy escaping from the barrage. The minimum head loss at the maximum discharge produces a very low Froude Number resulting in very little hydraulic jump.

(10) 2D-Model Studies for Basantpur Barrage across Mahanadi River in Janjgir- Champa Dist. (Chattisgarh).

83RR(H_2-05)

Model studies were conducted for Basantpur barrage, proposed to be constructed across Mahanadi River in Chattisgarh, on geometrically similar 2D-model built in a flume to the scale of 1:35. Observations from the hydraulic tests indicated that a waterway of 60 bays @ 12 m each with crest at elevation 209.50 m is adequate to pass a discharge of 35500 cumec. at HFL of 222.00 m with all bays fully opened.

Coefficient of discharge for barrage bays was worked out to be 1.08 for a discharge of 35500 cumec. The observed gate rating curves are shown through different drawings. No development of sub-atmospheric pressure was observed on crest and stilling basin. Performance of the energy dissipation arrangement was found to be adequate for negotiating the energy of flow escaping from the barrage.

(11) 2D-Model Studies for Kalma Barrage across Mahanadi River in Janjgir - Champa District, (Chattisgarh).

83RR (H_2-06)

Model studies were conducted for undersluice and barrage bays of Kalma barrage, proposed to be constructed across Mahanadi River in Chattisgarh, on geometrically similar 2D-model built in a flume to the scale of 1:35.

observations from the hydraulic tests indicated that the proposed clear water way of 936 m (736 m for barrage bays & 200 m for undersluice bays) with barrage crest at El. 192.00 m and undersluice crest at El. 191.00 m was observed to be adequate to pass the design discharge of 40500 cumec at 202.600 m HFL with all bays fully opened. Coefficient of discharge for undersluice bays and barrage bays were worked out to be 1.113 (for 9000 cumec discharge) and 1.159 (for 31500 cumec discharge) respectively. No development of sub-atmospheric pressure had been observed on crest and stilling basin. Performance of the dissipation arrangement was found to be adequate for negotiating the energy of flow escaping from the barrage.

(12) 2D-Model Studies for Sheorinarayan Barrage across Mahanadi River in Janjgir-Champa District, (Chattisgarh).

83RR (H_2-07)

Model studies were conducted for Sheorinarayan barrage, proposed to be constructed across Mahanadi River in Chattisgarh, on geometrically similar 2D-model built in a flume to the scale of 1:35. Observations from the hydraulic tests indicated that the proposed clear water way of 600.00 m with barrage crest at El. 215.30 m was observed to be adequate to pass the design discharge of 31000 cumec at an HFL of 228.457 m with all bays fully opened. Coefficient of discharge for barrage bays was worked out to be 1.035 for a discharge of 31000 cumec. The observed gate rating curves are shown through different drawings. No development of sub-atmospheric pressure was observed on crest and stilling basin. Performance of the energy dissipation arrangement was found to be adequate for negotiating the energy of flow escaping from the barrage.

(13) 2D-Model Studies for Saradih Barrage across Mahanadi River in Janjgir - Champa District, (Chattisgarh).

83RR (H_2-08)

Model studies were conducted for Saradih barrage, proposed to be constructed across Mahanadi River in Chattisgarh, on geometrically similar 2D-model built in a flume to the scale of 1:35. Observations from the hydraulic tests indicated that the proposed clear water way of 972 m with barrage crest at El. 197.00 m was observed to be adequate to pass the design discharge of 38500 cumec at 208.40 m HFL with all bays fully opened. Coefficient of discharge for barrage bays was worked out to be 1.004 for a discharge of 38500 cumec.

The observed gate rating curves are shown through different drawings. No development of sub-atmospheric pressure was observed on crest and stilling basin.

Performance of the energy dissipation arrangement was found to be adequate for negotiating the energy of flow escaping from the barrage.

(14) Hydraulic Model Studies for Reservoir Sedimentation and Flushing of Upper Marsyangdi-2 HEP, Nepal.

83RR (H_2-09)

Hydraulic model studies were conducted on the existing geometrical similar model (scale 1:40) for Upper Mersyangdi-II HEP, Nepal in order to have an idea about the extent and profile of sediment deposits in reservoir, Under ponded conditions, the equilibrium state of the reservoir with respect to silting is achieved within 2 days to 7 days depending upon the sediment load and discharge in the river. With the increase in the sediment load, time for the occurrence of equilibrium goes on reducing.

The equilibrium state is not much dependant on the operation of gates or diversion tunnel. For the various conditions mentioned in the report, maximum sediment deposited near intake of diversion tunnel and power intake was observed as El. 1680.00 m and El. 1682.00 m respectively. As far as flushing of sediment deposit is concerned, flushing through right bay of spillway is observed to be more effective than the flushing through diversion tunnel and power intake. Almost all the deposited sediment was seen flushed when a discharge of 250 cumec is passed through the right spillway for one day under free flow conditions keeping power intake closed.

(15) Further Model Study for Vishnugad Pipalkoti HEP, Uttarakhand.

83RR (H_2-10)

Further model studies for Vishnugad Pipalkoti H.E.P, Uttarakhand were conducted on the existing comprehensive physical model constructed on a geometrically similar scale of 1:50 after incorporating the ground surface profile and location of various components of project according to the latest data supplied by THDC Ltd. The observed various parameters were compared with the results of previous experiments as per T.M. No. 81 RR (H_2-09), September, 2010. The discharging capacity of all the spillways (when operated simultaneously) got increased to 10500 cumec as compared to 10150 cumec, observed in previous study. In isolated operation, discharging capacity of sluice & ogee spillway got reduced but at the same time discharging capacity of both tunnel spillways got enhanced in comparison to the previous study. With the present topography surrounding the mouth of spill tunnel, formation of vortices of diameter up to 6.00 m diameter and 15-20 m depth were also seen. Therefore, suitable anti-vortex arrangement should be provided depending upon the final topography in the vicinity of the mouth of spill tunnel.

A maximum sub-atmospheric pressure of 9.50 m was observed at one point in diversion cum spill tunnel which was eliminated by the installation of an air vent pipe of diameter 3.0 m at that point. However, no sub-atmospheric pressures were observed in spill tunnel. Sub-atmospheric pressures were also observed along sluice spillway and bucket profile but were found within the permissible limits.

(16) Model Study for Main Dam Concrete Spillway of Hassan Dam Project, Republic of Yemen.

83RR (H_2-11)

Model studies were conducted for concrete spillway of Hassan Dam project (Republic of Yemen) on a geometrically similar sectional flume model built to scale 1:25. The hydraulic tests conducted on the model indicated that the concrete spillway provided is quite adequate to pass the discharge of 4771 cumec at reservoir level of 137.40 m as compared to the proposed maximum reservoir level of 137.50 m. Rating curve for the concrete spillway developed for free flow conditions is shown in drawing. The energy dissipation arrangement in the form of USBR Type-II stilling basin was found to be

adequate as the hydraulic jump was forming on the glacis for all discharges upto 4771

cumec. Profile of spillway was observed to be alright as far as the development of pressure on the surface is concerned. Hydrostatic pressures developed on spillway profile were observed to be within permissible limits. Average residual velocity of the order of 2.04 m/sec was observed at 10 m d/s of the end sill of the stilling basin for a discharge of 4771 cumec.

(17) Compilation and Analysis of Observations Recorded at Meteorological Observatory, Hydraulic Division-II, Bahadrabad.

83RR(H_2-12)

Various elements of meteorological observations such as temperature, relative humidity, rainfall, wind velocity, vapor pressure, sediment concentration and evaporation rate were observed at Meteorological Observatory, hydraulic Division-II, Bahadrabad in the year 2012. Maximum and minimum temperature of the year was found to be 44 ^{0}C on 20-06-2012 and 2.5 ^{0}C on 14-01-2012 respectively. Out of total of total 741.3 mm rainfall in the year 2012, about 89.88% of total rainfall was received between July to September. The wettest month of the year was August 2012 in which 444.8 mm rainfall was observed. Total numbers of rainy days were 46. Maximum average wind velocity was 5.4 km/hr on 22-03-2012, 21-04-2012 and max. vapour pressure of 26.4 mm was observed on 17-07-2012. Max. rate of evaporation, 9.5 mm/day, was observed on 17-06-2012.

A total evaporation loss during the year was 1155.4mm. Maximum sediment concentration in the feeder channel of HRS was observed as 5920 ppm on 10-07-2012

(iii) HYDRAULIC DIVISION – III

(18) Annual Report Hydraulic Div.-III

83RR (H_3-01)

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 2012-13.

(19) Model Studies for Protection of South Guide Bund of Bogibil Bridge across River Brahmaputra (Assam)

83RR (H_3-02)

The model studies were carried out to observe the behaviour of man-made structure and safeguard the guide bunds of Bogibil bridge having waterway of 4875 m, across river Brahmaputra with the river bed configuration of post flood 2011 with some proposal of spur(s). The studies have been conducted on the existing physical model built to horizontal scale of 1:400 and vertical scale of 1:50. The observation during hydraulic tests indicated

that a combination of three spurs at 1900 m u/s, 1700 m u/s and 1500 m u/s of BCL having 100 m length in channel and 200 m length on ground (parallel to cross section lines) with top levels 104.0 m. developed comparatively satisfactory flow condition, which can be considered as an option.

(20) Model Studies for Desilting Chamber Rangit (Stage-IV) H.E Project (Sikkim).

83 RR (H_3-03)

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 sloping 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 desired 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

(21) Model Studies for Uniform Discharge Distrubution Through Spillway of Rangit (Stage-IV) H.E Project (Sikkim),

83RR (H_3-04)

Hydraulic model studies were conducted for revised spillway profile of Rangit Stage IV H.E. Project (Sikkim) on a geometrically similar comprehensive model built to a scale of 1:40. The studies indicated that the proposed water way of 40.0 m having its crest at El. 445.0 m and brest wall with its invert at El. 459.0 m was found adequate to pass 5617 cumec discharge (SPF) at reservoir El. 464.8 m under free flow condition through all the four ways fully open. The modified shape of left wing wall having 40 m radius gave better flow wing wall was almost similar under ponding condition.

(22) Model studies for Desilting Chamber of Teesta (Stage-VI) H.E.P (Sikkim),

83RR (H_3-05)

Model Studies were conducted for proposed Desilting Chamber of Teesta (Stage-VI) H.E. Project on a geometrically similar model built to scale of 1:15. Studies for silt removal efficiency of the chamber indicated overall silt trapping efficiency and silt trapping efficiency for +0.2 mm particle size of the order of 75% and 94% respectively. All holes were found open upto silt load of 2000 ppm at intake. When silt load was increased to 3500 ppm and 4500 ppm, few holes in downstream position were found chocked. The SFT was found clear during all experiments. The sediment deposition at side slopes and upstream slope was maximum of 0.15 m upto 2000 ppm silt load. At higher silt load, the sediment deposition at side slopes was found to be increased. In view of the above, it is advised that the flushing with design discharge must be continued in non-monsoon period also.

(iv) HYDRAULIC DIVISION – IV

(23) Capacity Survey of Pili Reservoir

83 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.

(v) GROUND WATER DIVISION- I

(24) Annual Report, Ground Water Division-I

83RR (GW_1-01)

Ground Water Research Division-I, one of the four divisions of Basic Research Circle of I.R.I. Roorkee generally caters to the needs 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. In addition to this the Division 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. The present report covers subject wise studies carried out in the division during 2012-2013, publications, organizational set up.

(vi) GROUND WATER DIVISION- II

(25) Annual Report, Ground Water Division–2.

83RR (GW_2-01)

The studies and activities undertaken by the ground water division-2 during the year 2012-13 are documented in the report.

(26) Hydraulic Performance of Pressure Release Valves.

83RR (GW_2-02)

OMMA Pvt. Ltd. New Delhi provided three Pressure Release Valves for testing their hydraulic performance required to be used in irrigation canals. The single ball type and four ball type valves were tested in horizontal position while the flap type valve was tested in horizontal position with the slope provision of 1:1.5 respectively as desired by the sponsor. The test results are shown in reports. The hydraulic performance of Pressure release valves is found satisfactory and the same may be used at suitable locations of the structure.

(27) Feasibility report on Artificial Ground Water Recharge for Mahendrgarh district of Haryana.

83RR (GW_2-03)

The report deals with feasibility study and preparation of DPR for artificial ground water recharge in Distt. Mahendragarh of Haryana State. The Sponsor (PHEC,Rewari) informed that needs of water in the district for agriculture, drinking and industrial purposes are fulfilled by ground water because of that the ground water has become over burdened and overexploited. This phenomenon exists only when extraction of ground water is more than the natural recharge. Therefore need for

artificial recharge exists but its feasibility has to be studied as per guidelines provided in CGWB Manual on Artificial Recharge of Ground Water.

The district, falls under semi-arid with low moderate rainfall, has five blocks (Kanina, Mahendragarh, Nangal Choudhary, Ateli and Narnaul). The stage of ground water development for each block (100%, 205%, 184%, 200% and 197%) has been evaluated separately. All the five blocks of the district fall under overexploited and critical category. Therefore, need for artificial recharge exists in the district but due to non availability of source water, implementation for artificial recharge scheme may find no way except to identify the areas where surplus and unutilized runoff may be made available as source water. Hence the proposal for artificial recharge scheme at toe of Aravali hill (Mahendragarh, Ateli and Narnaul blocks) by tapping runoff water (about-19.94 mcm) as source water have been suggested to adopt the scheme partially. In addition to that, some other alternative sources to import the water for recharging have been identified in context of need for artificial recharge.

(vii) BASIC DIVISION

(28) Annual Report, Basic Division

83RR (B-01)

This division is responsible for the maintenance of Computer Center of the institute, organizing training programs for officers and staff of Irrigation department, vocational trainings for engineering graduates of different university/engineering colleges. In addition, this division also takes up discharge measurement works for irrigation canals and rivers. The division has facilities for A0 size digital scanner and colored printer also.

The Division maintains a Remote Sensing and GIS Laboratory also, which was established in 1997. Since then the laboratory 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. The present report covers subject wise activities carried out in the division during 2012-13 publications, organizational set up and financial status of the division.

(29) Digital map of Uttarakhand with location of Dams, Barrages and Weirs on Rivers along with their features

83RR (B-02)

Remote Sensing techniques have been adopted by using Erdas Imagine and Arc-View software for the study, which provides digital map of Uttarakhand with location of Dams, Barrages and Weirs on Rivers along with their features. In the present study, the state map of Uttarakhand released by Survey of India, Dehradun has been used for creation of digital map. Considering the Longitude and Latitude, coordinates have been used to indicate the location of Dams, Barrages and Weirs on the Rivers. Other features of digital map have been digitized by applying the G.I.S. tools e.g. Point, Line and Polygon.

(viii) MATERIAL TESTING DIVISION-II

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

83RR (MT_2-01)

The report deals with activity and financial status of Material Testing Division –2, for the year 2012-13.

(31) Analysis of pull-out test results for proposed revision of IS Code: 11309 1985 (reaffirmed in april 2011)

83RR (MT_2-02)

The present report deals with analysis of data for in-situ Pull-Out Test results conducted by research personnel of rock Mechanics Lab, IRI as per IS Code :11309 -1985 (Reaffirmed in April, 2013). In all 215 tests were conducted during 1989 -2008 in four project sites of UP & Uttarakhand. Out of this, 105 tests with threaded anchor bar and 110 tests with welded anchor bar were used in conducting

the test. The idea for holding the central hole jack with the help of welding in conducting in-situ pull-out test was initiated for the first time by IRI, Roorkee in two project sites of U.P. The analysis of test results reveal that failure of threaded anchor bars are generally observed to take place at threaded portion while no failure of anchor bar was observed at the welded portion. It is, therefore, recommended that welded bar may be preferred in place of threaded bar in conducting Pull-Out Tests. Alternatively other options may also be explored in finding out the realistic results.

(ix) SOIL DIVISION- I

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

83RR (S_1-01)

The studies and activities undertaken by the Soil Division - I during the year 2012 -13 are documented in the report.

(33) Determination of Elastic and Shear Properties of Foundation Rock at the site of Proposed Kosi Barrage Almora (Uttarakhand)

83R.R. (S_1-03)

One no. in-situ concrete-rock shear test and two nos. cyclic plate load test have been conducted at the site of Proposed Kosi Barrage, Almora (U.K).

The analysis of observed data on concrete-rock block shear test has yielded c=1.80kg/cm², F =45º at peak strength and c= 0.80kg/cm², F =39º at residual strength.

Cyclic plate load test were performed in five cycles, both up to the maximum stress level of 66.67 kg/cm². On the basis of these tests, the modulus of deformation for underlying rock has been worked out to 2.10×10^4kg/cm² and the value of elastic modulus as 2.78×10^4kg/cm².The value of elastic settlement and total deformation for the raft foundation of size 70.0m x 54.24m at the design loading intensity of 45.ot/m² are 5.48mm and 7.23mm respectively, which lies in the safer zone of permissible limit of settlement for the underlying rock.

(34) Determination of Bearing Capacity for the Foundation of proposed Rohin Barrage-3, Maharajganj (U.P)

83 R.R. (S_1-07)

This report deals with sub?Soil investigation for undisturbed / disturbed samples and Standard Penetration Tests (SPT) have been carried out in six bore holes at the proposed Barrage. The test results indicate that the foundation strata contains band of poorly graded sand (SP), sand- silt mixture (SP-SM) and clay of low to medium plasticity (CL) and (CI). The average no. of corrected SPT blows (N?) in sandy strata have been found 18,28,25,18,20 and 17 in six bore holes respectively. The clay bands in the foundation strata are observed normally consolidated.

The data obtained from the field and laboratory tests have been analyzed for bearing capacity evaluation. A factor of safety 2.5 and permissible settlement of 50 mm for sandy strata and 75 mm for clay strata have been taken in the analysis. It has been found that settlement is the governing criterion. The allowable bearing capacity for proposed raft foundation of 49.0 m width of barrage has been worked out to be 8.19 T/m².

(35) Determination of In-Place Permeability by Auger Hole Test Method at the site of proposed Rohin Barrage-3, Maharajganj (U.P)

83RR (S_1-09)

The Auger Hole Permeability has been conducted at seven points. The analisys of data observed, indicates that the coefficient of permeability below the water table for poorly graded sand (SP), silt (ML), silty clay (ML-CL) and clay of low plasticity (CL) have been found to be of the order of 10^{-2} cm/sec , 10^{-4} cm/sec, 10^{-4} cm/sec and 10^{-5} cm/sec respectively. These values for poorly graded sand silt mixture (SP-SM) and silty sand (SM) are ranging from 10^{-3} cm/sec to 10^{-2} cm/sec.

(b) **ABSTRACTS OF TECHNICAL/RESEARCH PAPERS PUBLISHED DURING 2012-13**

1- Sediment Deposition Study of the Reservoir for Rihand Dam Project – A Case Study.
(Authors: Aditya Kumar Dinkar, Dr. Subhash Mitra, Shankar Kumar Saha)

Paper published in Seminar on Sedimentation in Reservoirs (21st December 2012) Organized by Water Resources Department, Bureau of Indian Standards, New Delhi.

Abstract

The Rihand reservoir was designed for a total storage capacity of 10,608.32 Mm^3 with a provision of dead storage of 1628.38 Mm^3 for sediment deposits and live storage of 8979.94 Mm^3 for a period of 140 years to supply water for hydropower generation and several thermal power plants located in adjoining areas. It was also estimated that the live storage would be reduced from 8979.94 Mm^3 to 8185. 49 Mm^3 (8.84%). The adopted design value of sediment yield was 904 m^3/sq km/yr. The project was commissioned in 1962. No capacity survey of Rihand reservoir was carried out for a period of over three decades after commissioning of the project. The first reservoir survey of the project was done in 1995 before monsoon and again it was carried out after 8 year of first survey in 2003 before monsoon. After first survey, it was observed that the total storage capacity was found to have reduced significantly from 10,608.32 Mm^3 to 9,324.81 Mm^3 (12.09%) with a sediment yield rate of 3023 m^3/sq.km/yr. The reservoir was observed to suffer a further reduction in total storage capacity from 9,324.81 Mm^3 to 9019.33 Mm^3 (15%) in second capacity survey with a slightly decreased sediment yield rate of 2962 m^3/sq.km./yr which warrants immediate remedial measures to control the heavy sedimentation in the reservoir.

2- Cavitation Studies of Chute Spillway for Asia's Highest Dam – A Case Study.
(Authors: Aditya Kumar Dinkar, Dr. Subhash Mitra, Shankar Kumar Saha, Ajay Kumar Sharma)

Paper published in Seminar on Dams and Spillways in Himalayan Regions (30th November, 2012) Ogranized by Water Resources Department, Bureau of Indian Standards, New Delhi.

Abstract

Tehri dam is the highest dam of India having a combination of spillways viz. shaft spillways and chute spillway to allow the surplus di scharge to pass safely to the downstream of the dam. The chute spillway of the Tehri dam being a high head spillway, subjected to very high velocity flows to the tune of 50 m/sec near its toe and may result in to damages of spillway floor due to cavitation. Therefore, an aeration arrangement was needed for protection of spillway surface against cavitation. To evolve a suitable aeration arrangement, hydraulic model studies were conducted on a geometrical similar model built to 1:40 scale. In all, four alternative proposals were tested. The test results indicated that three number aerators located at the distances 230 m (El. 773.16), 310m El. 731.05 and 410 m (El. 678.42) respectively from the crest axis of control structure aerated the boundary flow to the required extent as per I.S. specifications. The hydraulic design on the basis of model studies of aerator having ramp heights of 0.2m, 0.15m and 0.10 m for respective aerator was found satisfactory, which was finally adopted for the construction of chute spillway of Tehri Dam and has been reported to have performed quite satisfactorily during last seven years.

3- Authenticity of Different Formulae Used for the Flow Measurement in Open Channel by Sharp-Crested Weir.

(Authors: Aditya Kumar Dinkar, Dr. Subhash Mitra, Shankar Kumar Saha)

Paper published in Water and Energy Journal, Volume 69, No. 7, July 2012 CBI&P, New Delhi.

Abstract

The hydrologic factors, one of the significant factors considering in water resources development, influence and determine the magnitude of availability of water which can also be measured by rate of flow of water. Quantitative water/flow measurement is done broadly by two methods i.e. direct method and indirect method. Generally, hydraulic structures such as weirs & notches, an overflow structure, are suitable for accurate determination of low discharges.

The basic formulae for measuring discharge of flowing water over the crest of a sharp crested weir are

$$Q = C_d \frac{2}{3}\sqrt{2g}\ \ LH^{3/2}$$ - without end contraction

$$Q = C_d \frac{2}{3}\sqrt{2g}\ \ (L - 0.1nH)^{3/2}$$ - with end contraction

Where , Q = discharge in cumec, C_d = Coefficient of discharge
g = Acceleration due to gravity (m/sec^2), L = Length of the weir (m)
n = No. of end contraction, H = Head over the crest (m)

The value of C_d which accounts for the frictional losses, depends on various factors viz. head over the crest, depth of flow in the upstream of the crest, approach velocity, etc. and is worked out by experimental observations. In general practices Francis, Bazin and Rehbock's formulae out of various formulae are the most commonly used to measure the discharge. Different authors/researchers gave different formulae of C_d with some modifications for Rehbock's formula. From laboratory observations, it was concluded that the results of computations of discharge by Francis, Rehbock formula modified by Jagdish Lal, PN Modi & SM Seth and and formulae as given in IS:1193-1959 as well as IS 9108-1979 (Reaffirmed 1997) show consistent results which were found to be in close agreement with the observed results. The analysis of the results also reveal that the difference between the observed and computed discharges was of the order of 2% up to 0.25 m head and insignificant effects in the variation of the slopes of u/s and d/s face of the weir.

4 – Use of Model Studies for Safe & Economical Design of Hydraulic Structure.

(Authors : Suresh Chandra Sharma, Dr. Subhash Mitra, Shankar Kumar Saha)

Paper published in Bhartiya Vaigyanik Evam Audyogik Anusandhan Patrika, Year 20, No. 1, June 2012, CSIR, New Delhi.

Abstract

Development of water resources plays a very important role in the overall development of any country. Besides this, proper management and utilization of water resources also help in flood control, water supply for drinking, industry, thermal and nuclear power plants, irrigation, hydro power generation, etc.

For the development and management of water resources, the design/ construction of various hydraulic structures and installation of related machines are an important task. Theoretical and empirical methods of analysis and calculations do not provide adequate solution to various hydraulic problems due to complexity of boundary, fluid and flow characteristics. The engineers involved in the designed of hydraulic structures are always keen to know the performance of such structures after its construction and commissioning of the project.

Therefore, there is no-option except to study the hydraulic phenomenon on a physical model. The validity of model predictions greatly depend upon the judicious simulation of the parameters, affecting the flow besides boundary characteristics. The studies of different parameters such as velocity distribution, pressure, behavior of flow, efficiency of design of hydraulic structure/ machines have been mainly carried out in the model studies to allow flow of water through a model constructed at a smaller/ bigger size than that of prototype. Hydraulic model studies are conducted mainly on the basis of Froude's law of similarity, Reynold's law similarity, etc. By physical electronic/electrical and mathematical/numerical modeling.

A number of model studies have been carried out at Hydraulic Research Station, Bahadrabad of IRI, Roorkee, a brief account of some important studies are presented in the article besides description of its basic principle and concept of the method of the model studies.

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 DIVISION – 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)	83 TR (MT_1-01)	Physical properties of cement sample received from Zonal Manager (N), CCI, 31-B, Rajpur Road Dehradun.
(2)	83 TR (MT_1-02)	Testing of Coarse aggregate received from Urban Works Unit, U P Jal Nigam, Bulandshahar.
(3)	83 TR (MT_1-03)	Testing of c.c. cubes received from Construction and Design Services, Unit-55, U P Jal Nigam, Meerut.
(4-7)	83 TR (MT_1-04, 05, 10,11)	Testing of tor steel received from Construction and Design Services, Unit-55, U P Jal Nigam, Meerut
(8)	83 TR (MT_1- 06)	Testing of tor steel, c.c. cubes, bricks, coarse aggregate and fine Aggregate received from Pacefed Nirman Prakhand, Gautambudhnagar.
(9-11)	83 TR(MT_1-07,26,41)	Testing of tor steel received from Nirman Khand-6, U.P. Avas & Vikas Parishad, Meerut.
(12)	83 TR(MT_1-08)	Physical properties of cement sample received from Irrigation Construction Division, Srinagar (Garhwal).

Sl.No.	T R No.	Title of Test Report
(13-15)	83 TR(MT_1-12,34,60)	Physical properties of cement sample received from Nirman Khand-6, U.P. Avas & Vikas Parishad, Meerut.
(16-20)	83 TR (MT_1-13,14, 15,16, 17)	Testing of bricks, coarse and fine aggregate received from Construction and Design Services, Unit-55, U P Jal Nigam, Meerut.
(21-50)	83 TR (MT_1-18,19,27, 28,29,30,33,36,37,44, 45,46,47, 50,51,57,58, 59,61,63,64,65,66,67, 77,78,79,80,81,82)	Testing of bricks received from Khara Project Construction Division-1 (Rehabilitation), Haridwar
(51)	83 TR(MT_1-20)	Testing of bricks, coarse and fine aggregate received from Administration Division, I.R.I., Roorkee
(52).	83 TR(MT_1-21)	Testing of C.C.Cubes received from Administration Division, I.R.I., Roorkee
(53-91)	83 TR (MT_1-22,23,24, 25, 31, 32,35,39,40,42, 43,48, 49,52,53,54,55, 56,68, 69,70,71,72,73, 74,75, 76,83,84,85, 89, 90,91, 92,101,102,105, 106,107)	Physical properties of cement sample received from Khara Project Construction Division-1 (Rehabilitation), Haridwar.
(92)	83 TR(MT_1-38)	Testing of G.I. wire received from Irrigation Division, Chamoli.
(93)	83 TR(MT_1-62)	Haridwar Development Authority, Haridwar.
(94)	83 TR(MT_1-09)	Testing of C.C.Cubes received from Nirman Nigam, Ghansali (Tehri Garhwal).
(95-96)	83 TR(MT_1-96,97)	Testing of tor steel & c.c.cubes received from U.P. Jal Nigam, Saharanpur.
(97)	83 TR(MT_1-103)	Testing of tor steel received from M/s O. P. Gupta Constructions (P) Ltd., Meerut.
(98)	83 TR(MT_1-104)	Testing of tor steel received from M/s O. P. Gupta Contractors (P) Ltd., Agra.

(b) **SOIL DIVISION - I**

The Soil Division-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
(99)	83 TR (S_1-02)	Classification Test on soil samples of pili Reservoir
(100)	83 TR (S_1-04)	Determination of Modulus of Subgrade Reaction of Foundation soil at Rohin Barrage-3, Maharajganj (U.P)
(101)	83 TR (S_1-05)	Classification Test on soil samples collected from bore holes at the site of proposed Rohin Barrage-3, Maharajganj U.P (Upstream BH No. 7 to 11)
(102)	83 TR (S_1-06)	Classification Test on soil samples collected from bore holes at the site of proposed Rohin Barrage-3, Maharajganj U.P (Downstream BH No.12 to16).
(103)	83 TR (S_1-08)	Determination of Bearing Capacity for the Foundation Soil of Head Regulator of proposed Rohin Barrage-3, Maharajganj U.P
(104)	83 TR (S_1-10)	Determination of Allowable Bearing Capacity of Foundation Soil for the proposed four Storeyed Women Hospital, Haridwar (Uttarakhand)

(c) SOIL DIVISION II

The Soil Division-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
(105)	83 TR(S_2-2)	Chemical analysis of P.P.C Cement sample received from Prahlad Verma, Vill & Post Kumma, Tehsil Jansath, Distt Muzaffar nagar (Uttar Pradesh)
(106-108)	83 TR (S_2-3,4,5)	Chemical analysis of cement concrete samples received from Executive Engineer Haridwar Development Authority, Haridwar, Uttarakhand.
(109-113)	83 TR (S_2-6,7,8,9,10)	Chemical analysis of P.P.C Cement sample received from Project Manager, Unit -55 & D.S., Uttar Pradesh Jal Nigam , Meerut.
(114)	83 TR (S_2-11)	Chemical analysis of cement mortar sample received from Exeutive Engineer, haridwar Devlopment Authority, Haridwar (Uttarakhand).

SECTION - E

(a) OFFICER IN-CHARGE DURING THE YEAR 2012-13

Chief Engineer (Design) & Director IRI, Roorkee	Er. A.K.Dinkar
HYDRAULIC CIRCLE	
Superintending Engineer	Er. N.K. Sharma
HYDRAULIC DIVISION - I	
Research Officer	Er. S.K.Saha
Assistant Research Officer-I	Er. B.D. Joshi
Assistant Research Officer-II	Sri Surendra Mohan
Assistant Research Officer-III & IV	Er. Gunanand Sharma
HYDRAULIC DIVISION – II	
Research Officer	Er. Ajay Kumar Sharma
Assistant Research Officer-I	Sri. Ajay Kumar
Assistant Research Officer-II	Er. B.D Joshi
Assistant Research Officer- III	Sri Surendra Kumar
Assistant Research Officer-IV	Sri Ram Ashish

HYDRAULIC DIVISION III

Research Officer	Er. N. K. Sharma
Assistant Research Officer-I	Er. B.D. Joshi
Assistant Research OfficerII	Sri Dheer Singh
Assistant Research Officer-III	Sri Ram Swaroop
Assistant Research Officer IV	Sri Mohan Lal Gupta

HYDRAULIC DIVISION IV

Executive Engineer	Er. S. K. Agarwal
Assistant Research Officer	Sri Vinod Kumar

BASIC CIRCLE

Superintending Engineer	Er. N.K. Sharma
	Er. L.K. Sharma

GROUND WATER DIVISION - I

Research Officers	Er. L.K. Sharma
	Er. N.K. Sharma
Assistant Research Officer-I	Sri Sushil Kumar
Assistant Research Officer-III	Sri Surendra Kumar

GROUND WATER DIVISION II

Executive Engineer	Er. L. K. Sharma
Assistant Research Officer-I	Sri R. R. Mohan
Assistant Research Officer- II	Er. O.P. Arora

BASIC DIVISION

Research Officer & ARO-I	Sri Sushil Kumar
Assistant Research Officer-III & IV	Sri Chhatter Singh

MATE RIAL TESTING DIVISION - II

Executive Engineer	Dr.Subhash Mitra
Assistant Research Officer - II	Er. O.P. Arora
Assistant Research Officer - III	Sri Ajay Kumar

MATERIAL TESTING CIRCLE

Superintending Engineer	Er.R.K. Gupta

MATERIAL TESTING DIVISION - I

Executive Engineer& A.E- I	Sri Bijendra Pal
Assistant Engineer- IV	Sri Sukhvir Singh

SOIL DIVISION – I

Research Officers	Er. L.K. Sharma Er. Puneet Kumar Mall
Assistant Research Officer -I & IV	Sri Bijendra Pal Sri Kanwer Pal
Assistant Research Officer - III	Smt.Sheela Rani

SOIL DIVISION – II

Research Officer	Er. Sudhir Kumar
Assistant Research Officer -I & II	Sri Kishan Lal

ADMINISTRATIVE DIVISION

Executive Engineer	Er. L.R. Arya
Assistant Engineer -I & II	Er. Jagpal Singh
Assistant Engineer -III	Er. Upendra
Assistant Engineer -IV	Er. Gunanand Sharma
Assistant Engineer -V	Er. Sarvan Kumar Goel

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

Sl. No.	Name of Meeting/ Seminar/ Workshop etc.	Place	Date	Name of Research Personnel who attended
1	Training on " Web Based Hydrological Tools"	NIH, Roorkee	12-15 March, 2012	Er. S.K. Saha, Executive Engineer
2	15th meeting of Water Resources Division Council (WRDC)	BIS, Manak Bhavan, New Delhi	19th July, 2012	Er. S.K. Saha, Executive Engineer
3	Meeting Regarding Feasibility of Ground Water Recharge in Distt. Mahendragarh, Haryana.	Public Health Department, Rewari (Haryana)	19 - 21 July, 2012	Er. L.K. Sharma Superintending Engineer Er. O.P Arora Assistant Research Officer Sri D.C. Ramola Scientific Assistant.
4	Seminar on "Dams and Spillways in Himalayan Regions"	BIS, Manak Bhavan, New Delhi	30th Nov, 2012	Er. S.K. Saha, Executive Engineer
5	Seminar on "Sedimentation in Reservoirs"	BIS, Manak Bhavan, New Delhi	21st Dec, 2012	Er. S.K. Saha, Executive Engineer
6	Executive Body Meeting of Indian Geo-Technical Society, Roorkee Chapter for IGC (2013)	Civil Engineering Deptt. IIT Roorkee.	Feb, 2013	Dr. Subhash Mitra Superintending Engineer
7	National Short Term Course on DPR Preparation & Evaluation for SHP Projects.	AHEC, IIT Roorkee.	9-12 April, 2013	Er. P.K.Mall Executive Engineer

(c) VISITORS

Sl. No.	Name & Designation	Project / Place	Date
1	Mr. R.K. Dayal, G.M. (Civil), RITES Mr. Jitendra Singh,A.G.M. (Civil), RITES Mr. S.K. Singh, D.G.M., (Civil), RITES Mr. Vikalp Pandey, G.T.,RITES	Rail cum Road Bridge at Bogibil	10/04/2012
2	Sri Jitendra Chaubey, Asst. Vice President GVK Sri R. K. Vakkalagadda, Manager (Civil) GVK Sri Rajeev Kumar, DGM GVK.	Ratle H.E. Project	16/04/2012
3	Mr. Jitendra Singh,A.G.M. (Civil), RITES Mr. S.K. Singh, D.G.M., (Civil), RITES Mr. Vikalp Pandey, G.T.,RITES	Rail cum Road Bridge at Bogibil	21/04/2012
4	Mr. Nadeem Ahamad, A. M.,RITES	-do-	10/05/2012
5	Mr. M.K. Sharma, M.D. JPCL Mr. D.Pal Verma, Director, JPCL Mr. Pawan Kumar Gupta, GM, JPCL Mr. Joginder Singh, Sr. Manager, JPCL Mr. S.S. Tyagi, Advisor, ICCS Mr. B.S. Srinivasan, AGM, ICCS Mr. Sri Ram, Manager, ICCS	Rangit Stage-IV H.E.P (Sikkim)	23/05/2012
6	Mr. I.K. Chugh, V.P, Lanco Mr. Praveen Kumar, G.M (Design), Lanco Km. Sireesha Gangula, J.E.T, Lanco Mr. K.P. Singh, Tech. Advisor, Lanco	Teesta Stage- VI	12/06/2012
7	Mr. Jitendra Singh,A.G.M. (Civil), RITES Mr. Vikalp Pandey, G.T.,RITES Mr. Jitendra Singh,A.G.M. (Civil), RITES Mr. S.K. Singh, D.G.M., (Civil), RITES Mr. Nadeem Ahamad, A.M.,RITES	Rangit Stage-IV H.E.P (Sikkim)	21/06/2012
8	Mr. Jitendra Singh,A.G.M. (Civil), RITES Mr. S.K. Singh, D.G.M., (Civil), RITES Mr. Vikalp Pandey, G.T.,RITES	Teesta Stage- VI	20/07/2012
9	Mr. Jitendra Singh,A.G.M. (Civil), RITES Mr. S.K. Singh, D.G.M., (Civil), RITES Mr. Vikalp Pandey, G.T.,RITES	-do-	26/07/2012
10	Mr. I.K. Chugh, V.P, Lanco Mr. T. Homan Singh, D.G.M (Design), Lanco Mr. K. P. Singh, Tech. Advisor, Lanco	-do-	24/08/2012
11	Mr. B.K. Sharda, C.O.O, Lanco Mr. S.K. Bhalla, E.D, Lanco Mr. I.K. Chugh, V.P, Lanco Mr. Yogesh Shah, Sr. G.M, Lanco Mr. Umesh Kumar, A.G.M, Lanco Mr. K.P. Singh, Tech. Advisor, Lanco Sri Anil Bhatnagar, E.D.	-do-	12/12/2012

Sl. No.	Name & Designation	Project / Place	Date
12	A group of foreign participants from Water Resource Development & Management, IIT Roorkee	Roorkee	13/12/2012
13	Sri M.M Madan, Director—GVK. Sri Rajeev Kumar, DGM (Civil) GVK Sri R. K. Vakkalagadda, Manger (Civil) GVK Sri Amar Pal Singh, Head-Hydro Engg. L&T-EDRC Sri Sanchit Mohindra, Asstt. Eng.(Civil), L&T-EDRC	Ratle H.E. Project	17-18/12/2012
14	Mr. Joginder Singh, Sr. Manager, JPCL Mr. S.S. Tyagi, Advisor, ICCS	Rangit Stage-IV H.E.P (Sikkim)	18-19/12/12
15	Sri Sheshmani Sonkar, Manager Design.	Model Study of I/O of Tehri Pump Storage Plant	21/12/2012
16	A group of students of B.Tech Final Year (JNU Jodhpur).	Jodhpur	28/12/2012
17	Sri A.C. Pandey, Consultant GVK	Model Study of I/O of Tehri Pump Storage Plant	10/2012 to 01/2013 (6 Visits)
18	Mr. Y.R. Pahuja, Sr. Vice President (Design)	Teesta Stage- VI	22/01/2013
19	Mr. Prasoon Kausik, Engineer	-do-	28/01/2013
20	A group of foreign participants from Water Resource Development & Management, IIT Roorkee	Roorkee	31/01/2013
21	Mr. Sanchit, A.M. L & T	Lata- Tapovan	13/02/2013
22	Mr. Amar Pal Singh, A.G.M. L & T Mr. Sanchit, A.M, L & T	-do-	21/02/2013
23	A group of participants from WRD Odisha	Odisha	02/03/2013
24	A group of foreign participants from Water Resource Development & Management, IIT Roorkee	Roorkee	11/03/2013
25	A group of Students of M.Tech, Centre for Excellence-Disaster Management, IIT Roorkee	-do-	18/04/2013

(d) VOCATIONAL TRAININGS IN IRI, ROORKEE.

Engineering Students of following Institutes took part as group trainees during 2012-13

Sl. No.	Name of Institution	Period (In Weeks)
B.Tech (Civil Engineering)		
1	National Institute of Technology, Kurukshetra, Haryana.	6
2	Lovely Professional University, Phagwara, Jalandhar	6
3	College of Engineering Roorkee, Roorkee, Haridwar.	6
4	IIMT Engineering College, Mahamaya Technical University, Noida (UP)	6
5	K.L.S. Institute of Engineering & Technology, Roorkee.	6
6	Shri Ram Swaroop, Memorial Group of Professional Colleges, Lucknow (U.P)	6
7	Maharishi Ved Vyas Engineering College, Jagadhari, Yamuna Nagar, (Haryana)	6
8	Global Research Institute of Management & Technology, Yamuna Nagar, (Haryana)	6
9	Guru Nanak Education Trust, Kheri, Shikohpur, Bhagwanpur, Haridwar, Uttarakhand.	4
10	TRANSLAM Institute of Technology & Management, Mawana Road, Meerut (U.P)	4
11	Institute of Technology & Management Translam Group of Institution, Meerut (U.P)	4
B.Tech (Geo Informatics)		
12	University of Petroleum & Energy Studies, Dehradun Uttarakhand	8
Diploma (Civil Engineering)		
13	Aastha Polytechnic, Yamuna nagar (Haryana)	6
14	Shivalik Polytechnic, Chhachhrauli, Yamuna nagar (Haryana)	6
15	K.L. Polytechnic Roorkee, Uttarakhand	4
16	Government Polytechnic Kashipur, U.S Nagar Uttarakhand	4
17	Government Polytechnic Srinagar, Pauri Garhwal Uttarakhand	4
18	Government Polytechnic Dwarahat, Almora Uttarakhand	4
19	Shakambhari Institute of Higher Education & Technology, Haridwar Uttarakhand.	4
20	Ramanand Institute of Pharmacy & Management, Jwalapur, Haridwar Uttarakhand	4
21	RIMT Polytechnic College, Sirhind Side, Mandi, Govind Garh, Punjab	4
22	B.S.M. College of Polytechnic, Roorkee Uttarakhand	4
23	Uttaratech Polytechnic, Dhannauri, Roorkee Uttarakhand	4
24	College of Advanced Technology, Roorkee Uttarakhand	4
25	Aastha Polytechnic, Yamuna nagar (Haryana)	4
26	Roorkee College of Polytecnic, Kishanpur Haridwar Uttarakhand	4
27	OM Institute of Technology Roorkee, Roorkee Uttarakhand	4
28	Bishambar Sahai Diploma Engineering Institute Roorkee, Roorkee Uttarakhand	2

(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 Limit)	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

Measurement of Discharge
using Tracer Technique

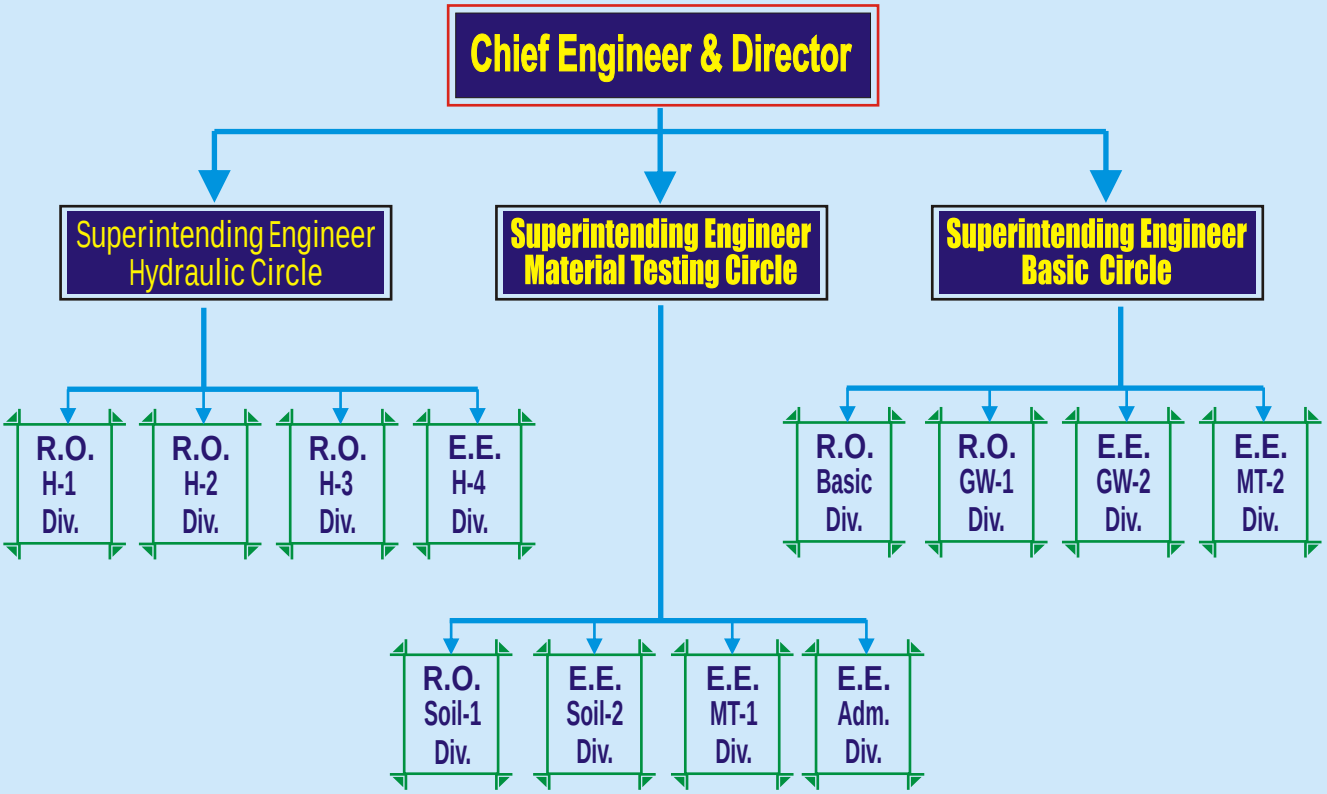
Meteorological Observatory Situated
at Bahadrabad

Abrasion Testing Machine in Material
Testing Laboratory

Visitors at Field Research Station, Bahadrabad (Hardwar)

Model Study for Protection of Golf Course, Sector – 3, Panchkula (Haryana)

Organisational Setup of Irrigation Research Institute



Assistant Engineer/Assistant Research Officer -32

Field Research Station, Bahadrabad

R & D Activities At a Glance

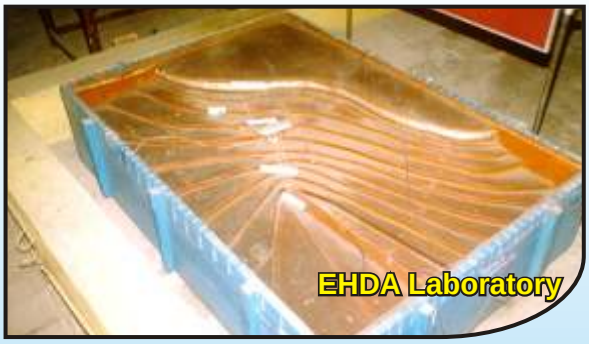

Meteorological Observatory


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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