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उत्तराखंड शासन

Annual Report
2011-12

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

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Technical Memo No. 82 **Year 2011-12**

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 project being executed by the U.P. Irrigation Department. Mr. Gerald Lacey, the propounder 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 material 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., 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, Oddisa, Uttar Pradesh, Haryana, Himachal Pradesh, J&K, Gujrat, Sikkim etc.

A list of studies carried out for different projects of national and international importance is shown under the title 'Important studies carried out by Irrigation Research Institute, Roorkee.

(b) Name of the Projects / Work for which Important Studies have been carried out by IRI Roorkee in the Past

- Hasan Dam (Republic of Yemen)
- Nyabarango Hydro-Electric Project, Rawanda, Africa
- Upper Marsyandi Hydro-Electric Project, Nepal
- Baglihar Hydro-Electric Project J&K, India / Pakistan
- Rangit Hydro-Electric Project (Sikkim)
- BanSagar Project, Mirzapur (U.P.)
- Karcham Wangtoo Hydro-Electric Project (Himachal Pradesh)
- Teesta Hydro-Electric Project (Sikkim)
- Tenga Dam Hydro-Electric Project (Arunachal Pradesh)
- Lahchura Dam, Mahoba (U.P.)
- Vishnugad Pipalkoti Hydro-Electric Project (Uttarakhand)
- Rongni Chu Hydro-Electric Project (Sikkim)
- Vishnu Prayag Hydro-Electric Project (Uttarakhand)
- Rangit Hydro-Electric Project (Sikkim)
- Lower Rajghat Canal, Lalitpur (U.P.)
- Nathpa Jhakri Hydro-Electric Project (Himachal Pradesh)
- Tehri Dam Hydro-Electric Project (Uttarakhand)
- Saurashtra Branch Canal (Gujrat)
- Koteshwar Hydro-Electric Project (Uttarakhand)
- Baspa Barrage (Himachal Pradesh)
- Kameng Hydro-Electric Project (Uttarakhand)
- Srinagar Hydro-Electric Project (Uttarakhand)
- Maneri Bhali Project (Uttarakhand)
- Rishikesh Barrage (Uttarakhand)
- Polavaram Project (Andhra Pradesh)
- Design of Sharda Type fall for Canals
- Design of surge systems under transient conditions for different H-E Project.
- Evolving criterion for design of energy dissipators at low Froude Number.
- Revision and updating of Manual on Canal Lining – A CBI&P sponsored project.
- Use of Isotopes for flow rate measurement, through canals and recharge due to rainfalls / applied irrigation.
- Development of low cost canal lining and compaction of embankments –A UNDP sponsored project.
- Development of high performance concrete for Vishnu Prayag Hydro-Electric Project (U.K.)
- Impact type Energy dissipators.
- Use of Anti-erosive coatings over concrete & steel – A basic study sponsored by INCCMS, New Delhi
- Revision of a Chapter on Sediment Transport for Publication No. 204 of CBI&P, New Delhi

(c) MAJOR STUDIES CARRIED OUT DURING 2011-12

(i) Hydraulic model studies of Miyar H.E.P. (Distt. Lahaul & Spiti, H.P.).

(ii) 2-D Model studies of Kalisindh Dam Project (Distt. Jhalawar, Rajasthan).

(iii) Hydraulic model studies for Diversion tunnel of Dibbin H.E.P. (Distt. West Kameng, Arunachal Pradesh).

(iv) 3-D Model studies of Kalisindh Dam Project (Distt. Jhalawar, Rajasthan).

(v) Model studies for Baitarani Small Hydro Electric Project (Orissa).

(vi) Model studies for revised proposal of Jorethang Loop Hydro Electric Project (Sikkim).

(vii) Model studies for Bajoli Holi Hydro Electric Project (HP).

(viii) Model studies for modified proposal of flushing tunnel of Teesta-III Hydro Electric Project (Sikkim).

(ix) Model studies for hydraulic performance of power intake of Teesta-III Hydro Electric Project (Sikkim).

(x) Model studies for desilting chamber of Teesta-III Hydro Electric Project (Sikkim).

(xi) Model studies for performance of power intake and reservoir sedimentation of Bajoli Holi Hydro Electric Project (HP).

(xii) Model studies for Rongnichu Hydro Electric Project (Sikkim).

(xiii) Design of concrete mixes for 2×4.5 MW Kaldigad Hydroelectric Project, Kaldigad, Maneri, Uttarkashi (Uttarakhand).

(xiv) Evaluation of shear parameters of soil samples for River Lawadi, Kashipur (Uttarakhand).

(xv) Enquiring properties of soil samples for Dulhasti power station (J&K).

(xvi) Design of concrete mixes for 2×2.25 MW Asiganga -II Hydrometric Project, Uttarkashi (Uttarakhand).

(xvii) 2-D Model studies for sluice spillway of Nyabarongo HEP-Rwanda (East Africa).

(xviii) Model studies for spillway and power intake of Nyabarongo HEP-Rwanda (East Africa).

(xix) Model studies for flood sluice of Hasan Dam (Republic of Yemen).

(xx) Model studies for reservoir flushing of Teesta-III Hydro Electric Project (Sikkim).

(xxi) Model studies for penstock bifurcation of Rampur Hydro Electric Project (HP).

(xxii) Model Studies for revised dam spillway of Rangit stage IV H.E. Project (Sikkim).

(xxiii) Model Studies for desilting chamber Rangit H.E Project (Sikkim).

(xxiv) Model studies of de-sander for Teesta H.E. Project Stage-VI (Sikkim).

(xxv) Further model studies for rail-cum-road bridge across river Brahamputra at Bogibil (Assam).

(xxvi) Determination of design parameters of foundation for proposed three storeyed EWS blocks at interlocks Residential Group Housing Plan-I site HDA Hardwar.

(d) ORGANIZATIONAL SET-UP

The Institute is headed by a Chief Engineer (Design) & Director with three Circles and 12 Divisions including Administrative Division with following distribution of works.

(1) Hydraulic Circle

i)	Hydraulic Division-I	H_1	Siting of Bridges, Barrages and Cross Drainage works including River Training & Flood Control works.
ii)	Hydraulic Division-II	H_2	Spillways and Outlets, Canal Regulators, Energy Dissipation, Desilting Chambers, Surge Tanks and Sedimentation studies.
iii)	Hydraulic Division-III	H_3	Spillways, Intake Works, Energy Dissipation and Rating of Current meters.
iv)	Hydraulic Division-IV	H_4	Capacity Survey of Reservoirs and Sedimentation Studies.

(2) Basic Circle

i)	Ground Water Division-I	GW_1	Application of Radioactive Isotope Technique for measurement of various hydrological parameters used in water management study. Mathematical Modeling technique used to study subsurface flow behavior below irrigation structures. In addition this division also maintains Institute Library.
ii)	Ground Water Division-II	GW_2	Measurement of seepage pressure and quantum of seepage beneath Hydraulic Structures by EHDA technique and suitability of drainage arrangement behind canal lining Low Cost canal lining and seepage measurement by ponding method. Preparation of DPR for artificial ground water recharge. Testing of Pressure Release valves.
iii)	Basic Division	B	Maintenance of Computer Centre of the institute, Imparting Computer training to the officers and staff of the institute, Computation of reservoir capacity by in house generated computer programme. Application of Remote Sensing and GIS in Water Resources Management, Discharge Measurement of channels, Vocational Training to Engineering students.

iv)	Material Testing Division-II	MT_2	Laboratory and In-situ Tests for engineering properties of rock mass and rock samples received from different hydroelectric / rever valley and irrigation projects. Besides this also published annual general report of the Institute as this division maintains the Publication Section of the Institute.

(3) Material Testing Circle

i)	Material Testing Division-I	MT_1	Optimal Design of Concrete Mixes (including High Performance Concrete) and Testing of various materials such as Cement, Concrete, Bricks, Tiles, Steel Bars etc.
ii)	Administrative Division	A	Maintenance of Colonies, Offices, Workshop and Stores at Roorkee and Bahadrabad. The division also looks after the accounts/finances of the Institute.
iii)	Soil Division-I	S_1	Field and Laboratory Testing of Soil related to the Foundation of Structures.
iv)	Soil Division-II	S_2	Testing of Soil Samples and Chemical Analysis of Water, Cement, Cement Mortar and Concrete etc.

(e) PUBLICATIONS

The following are the types of publications which were issued during the year 2011 -12:

(i) **Annual Report —** Annual Report for the year 2010-11 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. The expenditure incurred under various sub-heads during the year has also been presented in the annual report.

(ii) **Technical Papers and Research Reports —** During the year 2011-12. Five technical papers were sent for publication in various journal /conference and a total number of Thirty - six Research Reports were issued by the Institute on the basis of studies carried out by different divisions. A List of these Research Reports under different titles as given in Section-B and the abstracts of the Reports 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 2011-12, Fifty - five 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 activities of the institute regarding the studies 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 testing, geotechnical engineering, earth sciences, engineering geology, etc. There are more than 20000 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 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.
- Bhabha Atomic Research Centre (BARC), Mumbai.
- 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 THE ORGANIZATIONS LOCATED AT ROORKEE.

(i) Indian Institute of Technology Roorkee.

- Department of Civil Engineering.
- Department of Water Resources Development and Management Training.
- Department of Earthquake Engineering.
- Department of Hydrology

(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 & 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, New Delhi.

(j) Budget and Financial Accounting

Administrative Division is the only drawing and disbursing division of the Institute which caters for the financial functioning of the Institute. This division maintains the account of expenses incurred by different divisions in accordance with financial rules. The division is also engaged in procurement of materials, construction and maintenance work of residential and non-residential buildings of Irrigation Research Institute at Roorkee and Bahadrabad. The division is also responsible for the construction of all hydraulic models at Bahadrabad Research Station a field research unit located near Haridwar. The details of subhead-wise expenditure incurred during the year 2011-12 are as follows:

Sl. No.		Sub-Head	Expenditure (in ₹ Lacs)
(**A**).		8443 Civil Deposit	374.18
(B.)	(1)	4701 Expenditure of Research Facilities in I.R.I.	24.97
	(2)	2701 M&R	53.63
	(3)	2701- 02 Labour wages	23782.00
	(4)	2701 Contingency	28.70
	(5)	Travelling Expenses	0.40
(C.)		Pay and Allowances	905.07
		TOTAL (A+B+C)	**1624.77**

Technical Memo No. 82 **Year 2011-12**

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

(a) RESEARCH REPORTS

(1) HYDRAULIC DIVISION-I

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

Sl. No.	R.R. No.	TITLE OF REPORT
(1)	82 RR (H_1-01)	Hydraulic Model Studies of Miyar H.E.P. (Distt. Lahaul & Spiti, H.P.)
(2)	82 RR (H_1-02)	2-D Model Studies of Kalisindh Dam Project (Distt. Jhalawar, Rajasthan)
(3)	82 RR (H_1-03)	Hydraulic Model Studies for Diversion Tunnel of Dibbin H.E.P. (Distt. West Kameng, Arunachal Pradesh)
(4)	82 RR (H_1-04)	3-D Model Studies of Kalisindh Dam Project (Distt. Jhalawar, Rajasthan)

(2) HYDRAULIC DIVISION-II

Hydraulic Division-II, generally caters to the physical hydraulic modeling of dams, spillways, energy dissipators 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 provides mathematical modeling also in the field of desilting chambers, surge shafts, and water hammer. The division maintains a class "B" meteorological observatory and an Automatic Weather Station (AWS) for observing various climatic elements at Hydraulic Research Station Bahadrabad. Various studies carried out by this division during the year are :-

Sl. No.	R.R. No.	TITLE OF REPORT
(5)	82 RR (H_2-01)	Model studies for Baitarani Small Hydro Electric Project (Orissa)
(6)	82 RR (H_2-02)	Model studies for revised proposal of Jorethang Loop Hydro Electric Project (Sikkim)
(7)	82 RR (H_2-03)	Model studies for Bajoli Holi Hydro Electric Project (HP)
(8)	82 RR (H_2-04)	Model studies for Modified Proposal of Flushing Tunnel of Teesta-III Hydro Electric Project (Sikkim)
(9)	82 RR (H_2-05)	Model studies for Hydraulic Performance of Power Intake of Teesta-III Hydro Electric Project (Sikkim)
(10)	82 RR (H_2-06)	Model studies for Desilting Chamber of Teesta-III Hydro Electric Project (Sikkim)
(11)	82 RR (H_2-07)	Model studies for performance of power intake and reservoir sedimentation of Bajoli Holi Hydro Electric Project (HP)
(12)	82 RR (H_2-08)	Model studies for Rongnichu Hydro Electric Project (Sikkim)
(13)	82 RR (H_2-09)	2-D Model studies for sluice spillway of Nyabarongo HEP-Rwanda (East Africa)
(14)	82 RR (H_2-10)	Model studies for spillway and power intake of Nyabarongo HEP-Rwanda (East Africa)
(15)	82 RR (H_2-11)	Model studies for flood sluice of Hasan Dam (Republic of Yemen)
(16)	82 RR (H_2-12)	Model studies for reservoir flushing of Teesta-III Hydro Electric Project (Sikkim)
(17)	82 RR (H_2-13)	Compilation and analysis of observations recorded at meteorological observatory, Hydraulic Division-II, Bahadrabad during 2012
(18)	82 RR (H_2-14)	Model studies for penstock bifurcation of Rampur Hydro Electric Project (HP)

(3) HYDRAULIC DIVISION-III

The growing need of specialized hydraulic research for the hydroelectric projects got the creation of Hydraulic Division-3 during May 1965. Since its inception the Division has made significant contribution in evolving efficient hydraulic design of many hydroelectric projects. The experimental work is being carried out by four sub divisions of the division.

Presently 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 unique facility for rating current meters in northern India and carrying out current meter rating work for a variety of sponsors. The division is maintaining library and computer centre at the Hydraulics Research Station, Bahadrabad. Studies carried out during the year are :-

Sl. No.	R.R. No.	TITLE OF REPORT
(19)	82 RR (H_3-01)	Annual Report of Hydraulic Division-III
(20)	82 RR (H_3-02)	Model Study for Desilting Chamber of Singoli- Bhatwari H.E project. (Uttarakhand),
(21)	82 RR (H_3-03)	An Interim Report on Model Studies for Uniform Discharge Distribution through Tenga Dam spillway of Kameng H.E. Project (Arunachal Pradesh).

(4) HYDRAULIC DIVISION-IV

Hydraulic Division-IV deals with 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:- (i) Capacity survey of Matatila Dam Reservoir.
(ii) Capacity Survey of Pili Reservoir.

(5) GROUND WATER DIVISION-I

Ground Water 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. Besides 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 the year are given below:

Sl. No.	R.R. No.	TITLE OF REPORT
(22)	82 RR (GW_1-01)	Annual Report Ground Water Division-I
(23)	82 RR (GW_1-02)	Climate Change: An Overview
(24)	82 RR (GW_1-03)	Application of Mathematical Modeling in Ground Water Management
(25)	82 RR (GW_1-04)	Application of Ansys in Seepage Analysis below the foundation of hydraulic structures.

(6) 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, seepage losses from watercourses and minors by Ponding Method are also determined in canal lining laboratory of this division so as to achieve safety and optimization of the in design structures. This report presents various studies carried out during the year are given below :

Sl. No.	R.R. No	TITLE OF REPORT
(26)	82 RR (GW_2-01)	Annual Report Ground Water Division–2.
(27)	82 RR (GW_2-02)	A Compiled List of Technical Memorandums/Research Reports of Ground Water Div.-2 from 1955-56 to 2011-12.
(28)	82 RR (GW_2-03)	Institute at a Glance during year 2000 to 2011.

(7) 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.

Digitisation of old Research Reports, Research Papers & Manuals etc issued by Irrigation Research Institute, Roorkee are also being done so as to help in preserving the research divisions important documents in soft copy.

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 photoelastic technique is not being used for the estimation of stresses, although Photoelastic 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
(29)	82 RR (B - 01)	Annual Report of Basic Division
(30)	82 RR (B - 02)	Dams, Weirs and Barrages in Uttarakhand- A Data base in Arc-View

(8) 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:-

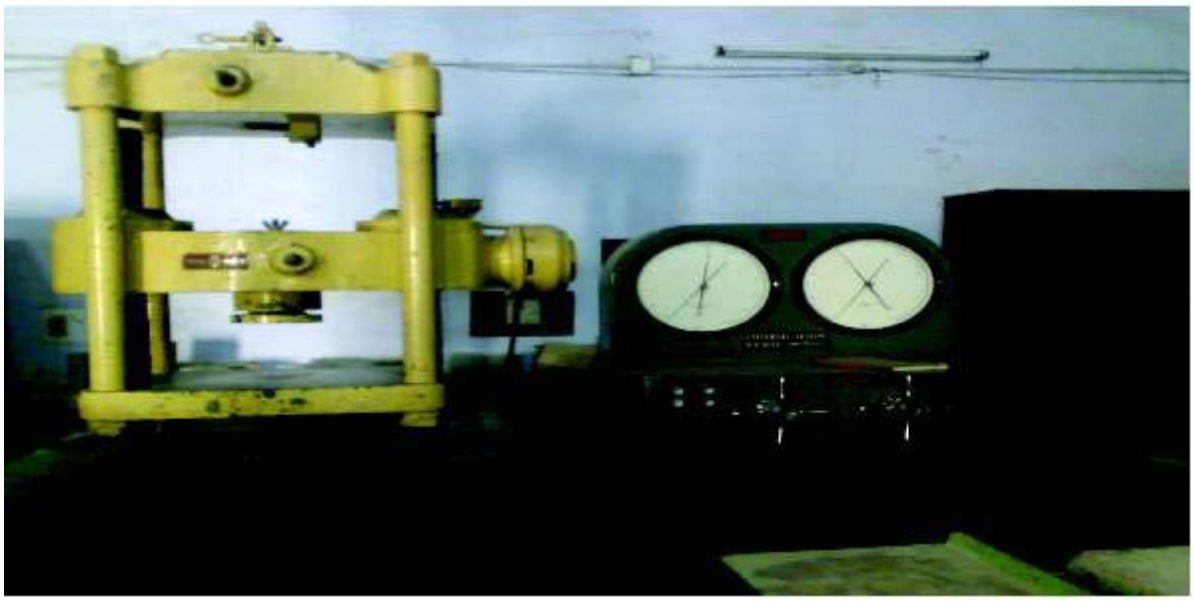
(i) Design of concrete mix including roller compacted concrete, high performance concrete and fibre reinforced concrete for construction of dams and other structures.

(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.



The various studies carried out by the division during the year are given below:

Sl. No.	R.R. No.	TITLE OF REPORT
(31)	82 RR (MT_1-01)	Design of concrete mixes for 2x4.5 MW Kaldigad Hydro Project, sponsored by Jal Vidhut Nigam Ltd., Maneri Uttarkashi.
(32)	82 RR (MT_1-02)	Design of concrete mixes for 2x2.25MW Asiganga-II Hydro Project, sponsored by Jal Vidhut Nigam Ltd., Maneri Uttarkashi.
(33)	82 RR (MT_1-03)	Design of concrete mix for siphon on Devha Baigul Power Canal, Bareilly sponsored by the Executive Engineer Ruhelkhand Canal Division, Bareilly.

(9) MATERIAL TESTING DIVISION – II

This division deals with the determination of engineering properties of rock mass and rock samples received from various projects. The publication section is also maintained by MT-2 Division. The important work carried out by this division during the year include testing of rock samples and in-situ test at two project sites, the details of which have been given in annual report as following :-

Sl. No.	R.R. No.	TITLE OF REPORT
(34)	82 RR (MT_2-01)	Annual Report Material Testing Division-2.

(10) 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 includes 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 includes 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
(35)	82 RR (S_1-03)	Annual Report Soil Division -1
(36)	82 RR (S_1-09)	Determination of design parameters of foundation for proposed Three Storeyed EWS Blocks at Inderlock Residential Group Housing Plan-I site HDA Haridwar.

(b) Technical Papers / Write up / Chapters

Sl. No.	Title of Paper / write up	Author's Name	Name of Symposium / Work shop
1*	Use of model studies for safe and economical design of hydraulic structures.	Shri S.C. Sharma Dr. Subhash Mitra Shri S.K. Saha	4th National Water Conference held on 16-17 Dec. 2011, NIH, Roorkee (Application of Latest Techniques in Water Resources Management)
2*	Importance of public participation in water resources management.	Shri S.C. Sharma Dr. Subhash Mitra Shri S.K. Agrawal	-do-
3	जल संसाधनो पर पर्यावरणीय प्रतिघात का मुल्यांकन	श्री सुरेश चन्द्र शर्मा एस0 के0 अग्रवाल सुधीर कुमाार	राष्ट्रीय जलविज्ञान संस्थान, रूडकी, द्वारा आयोजित "चतुर्थ राष्ट्रीय जल संगोष्ठी–2011 (जल संसाधनों के प्रबन्धन में नवीनतम तकनीकों का प्रयोग)" दिसम्बर 16–17, 2011
4	Sediment Transport	Sh. S.C. Sharma Dr. Subhash Mitra Er. S.K.Saha Er. P.K.Mall	Chapter V: River Behaviour, Management & Training, Vol. 1 of Publication No. 204 published by CBI&P, New Delhi has been revised.
5	Sediment Control in offtake channels	-do-	-do-
6	Silting of Reservoirs	-do-	-do-
7	Use of Cursed Rock for abrasion Resistant Concrete in Vishnu Prayag Hydel Project	Sh. S.C. Sharma Dr. Subhash Mitra Sh. P.K.Gupta	Journal of Rock Mechanics and Tunneling Technology, ISRMTT, India. Selected as best research paper for 2010 and awarded in 3rd Indo-Rock Conf. held in Oct. 2011 at CED, IIT, Roorkee.

*Technical papers have been selected for its inclusion in Journal "भारतीय वैज्ञानिक एवम् औद्योगिक अनुसंधान पत्रिका" नई दिल्ली

Er. Suresh Chandra Sharma, Former Chief Engineer & Director and Dr. Subhash Mitra, Superintending Engineer receiving the best Research Paper Award from Dr. Amalendu Sinha, CIM&FR, Dhanbad in third Indo-Rock Conference (Instituted by ISRMTT) held in Oct 2011 at IIT, Roorkee.

Dr. Subhash Mitra Receiving Excellence Performance Award Instituted by ISRMTT in Indo-Rock Conference held in Oct. 2011 at CED, IIT, Roorkee

Technical Memo No. 82 **Year 2011-12**

SECTION- C
RESEARCH REPORTS
INFORMATORY ABSTRACTS

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

(a) HYDRAULIC DIVISION - I

(1) Hydraulic Model Studies of Miyar H.E.P. (Distt. Lahaul & Spiti, H.P.)

82RR (H_1-01)

Hydraulic Physical Model studies were conducted with a geometrical similar model on 1:25 scale (discharge scale 1:3125) for the suitability of barrage axis, location of power intake & adequacy of waterway, etc. for Miyar Hydro Electric Project, Distt. Lahaul & Spiti, Himachal Pradesh. After model studies it was found that 20 m downstream of initially

proposed barrage axis would be optimal location for new barrage axis. The waterway of barrage having 3 sluice bays of size 10.0 m (W) x 4.0 m (H) were found adequate for passing design flood or even more under emergency conditions. No any formations of vortices or rotational flow were observed in front of power intake located at 15m upstream and perpendicular to proposed barrage at optimal location i.e. 20m downstream of initially proposed axis at different test conditions. However, detailed study of power intake shall be carried out in the next stage of model study with revised waterway of barrage.

(2) 2-D Model Studies of Kalisindh Dam Project (Distt. Jhalawar, Rajasthan)

82RR (H_1-02)

Determination of Rating curves, Co-efficient of discharge of Spillway Crest, Pressure & Flow profile and optimization of energy dissipators of Kalisindh Dam project, Jhalawar (Rajasthan), a multipurpose project proposed for drinking water supply, supply of water to Thermal Power Plant & Irrigation purposes were conducted by 2-D model studies to construct a geometrical similar

model on 1:37.50 scale. After optimization of energy dissipators, the length of stilling basin

was reduced to a length of 10.276 m and floor was allowed to raise by 0.77 m as per sponsor's proposal. A maximum positive pressure of the order of 15.00 m was observed while the maximum negative pressure was found less than the one tenth of the water head over the crest. An anicut having top level 2.68 m above the dam crest is already exist at 68 m u/s of proposed dam axis. Due to existence of anicut, the water level was raised upto a maximum value of 3.0 m at 100 m u/s of proposed axis.

(3) Hydraulic Model Studies for Diversion Tunnel of Dibbin H.E.P. (Distt. West Kameng, Arunachal Pradesh)

82RR (H_1-03)

Hydraulic Model studies were conducted with a geometrical similar model of scale 1:40 (discharge scale 1:10119) for the optimization of Diversion Tunnel, Dam spillways, etc. of Dibbin Hydro Electric Project, Distt. West Kameng, Arunachal Pradesh. After Model Studies it was found that the diversion tunnel is able to pass the design discharge (202 cumec) at a pond level of 0.3 m below the top of the upstream coffer dam. The outlet of diversion tunnel of expanding shape (angular variation of 1/3F) was found optimal. The maximum hydrostatic pressure of the order of 6.4 m was observed

at design discharge and there was no trace of formation of vortices at intake of the diversion tunnel. During observation, it was found that about 36% length (from beginning) of the diversion tunnel runs under pressurized condition and after that it runs free flow upto the end.

(4) 3-D Model Studies of Kalisindh Dam Project (Distt. Jhalawar, Rajasthan)

82RR (H_1-04)

3-D model studies were conducted on a geometrical similar model of scale 1:80 for optimization of rock cutting in upstream and downstream of Kalisindh Dam after incorporating stilling basin and energy dissipation arrangement for 75% (24308 cumec) of PMF of 32411 cumec.

The hydraulic test revealed that the very huge quantity of soil/rock cutting will be required in the downstream of the dam to pass the design discharge. As per Sponsor's requirement, the studies were conducted for 75% of PMF or design discharge. The rock cutting in downstream and upstream were made in stage wise to pass different discharges. The upstream and downstream water levels were observed in order to make a difference of minimum 1.5 m between

trunnion axis and water level below the trunnion at 75% PMF.

(b) HYDRAULIC DIVISION - II

A

(5) Model studies for Baitarani Small Hydro Electric Project (Orissa)

82RR (H_2-01)

Hydraulic model studies were conducted on a comprehensive geometrically similar model built to scale of 1:50 for proposed Baitarani barrage located in Keonjhar of district Orissa. The river reach from 0.7 km upstream and 0.5 km downstream from barrage axis was represented in the model. The tests conducted on the model for the design discharge of 11,132 cumec when allowed to pass with revised proposal indicated the pond level of 71.0m at barrage axis with all the bays of barrage and under sluice open while the average water level of all the bays of barrage was observed as 69.78 m (Table-1). The studies further indicated that the discharge of 14,194 cumec (1 in 500 year flood) when allowed to pass through the barrage, the reservoir level at barrage axis was observed as 73.0 m while the average water level of all the bays of barrage was found to be 72.67 as shown in Table-1. The details of final proposal of barrage which appears to give better hydraulic performance has been shown in Drg-3 to 5. From the model study it was also observed that approximately 80% of the design flood (11,132 cumec) passed through barrage bays while the rest of 20% passed through three under sluice bays. Water surface profile with barrage is given in Table-3 and discharge distribution through barrage bays is given in Table-4. Maximum afflux observed at barrage axis with design discharge of 11,132 cumec was 6.50m (Table-5) and discharge rating curve under free flow condition is shown in Drg-6.

(6) Model studies for revised proposal of Jorethang Loop Hydro Electric

82RR (H_2-2)

Hydraulic model study was referred to this Institute for barrage and power intake of Jorethang Loop H.E. Project (Sikkim). Accordingly the study was conducted on a comprehensive geometrically similar model built to scale 1:40 and the recommendations were issued vide T.M. No. 79 RR.(H_2-13) March 2009 and T.M. No. 81 RR(H_2-02), May 2010. Further studies were referred by the sponsors with revised proposal of barrage. The studies were conducted on the existing 1:40 scaled model of the structure. The formation of hydraulic jump on glacis was not seen. However deposition of silt was observed along the right guide bund. Hence the revised proposal of 2 under sluice bays and 5 barrage bays with reduced length & increased invert level of stilling basin had showed inadequacy in hydraulic performance.

(7) Model studies for revised proposal of Bajoli Holi Hydro Electric Project (Sikkim)

82RR (H_2-03)

The present report especially deals with hydraulic model studies conducted for the optimization of overflow section of Bajoli Holi H.E. Project (H.P.) on geometrically

similar comprehensive model built to scale of 1:40. The hydraulic tests conducted on the model indicated that 4 nos. sluices of size 10.0 m X 12.33 m of spillway are quite adequate to pass the P.M.F. at designed water levels with one gate inoperative also. The variation of discharge passing through spillway bays varies from 23.43% to 27.2% at P.M.F. (Drg.-5). The water surface profiles in upstream and downstream of spillway as observed on the model under different operating conditions are given in Drg. 6 & 7. The pressure observed along the spillway and pier profiles were found positive and negative at some location within permissible limit under free flowing conditions. The spillways rating curves as developed for free flow under gated conditions are shown in Drgs.-8 and 9 respectively. The maximum velocity of the order of 11.0 m/sec at discharge 7419 cumec was observed in downstream of plunge pool which warrants for necessary precaution. The studies regarding flow conditions at intake and sedimentation of reservoir are not covered in the present report. After the completion of studies, the report shall be issued subsequently.

(8) Model studies for Modified Proposal of Flushing Tunnel of Teesta-III Hydro Electric Project (Sikkim)

82RR (H_2-04)

The model studies for revised proposal of flushing tunnel of Teesta-III H.E. Project (Sikkim) were conducted on a geometrically similar comprehensive model built to scale of 1:40. The study indicates that the discharges of 1800 cumec and 1720 cumec at reservoir levels 1589.5 m (MWL) and 1588.0 m (FRL) respectively have been passed. Flow in the flushing tunnel was almost smooth and streamlined. No pulsating flow condition was observed. Vortex formation was observed at some reservoir levels. Hydraulic behaviour of flushing tunnel under both freeflow and gated condition is given in Table-3 and Table-4 respectively. Observed water depth in tunnel with different discharges is given in Table-5. Observed pressure distribution in the flushing tunnel under freeflow and gated condition is shown in Table-6 & Table-7 respectively. Rating curve in freeflow as well as in gated condition is shown in Drg-4. Water surface profile in the open outlet channel.

(9) Model studies for Hydraulic Performance of Power Intake of Teesta-III Hydro Electric Project (Sikkim)

82RR (H_2-05)

The model studies for hydraulic performance of power intake of Teesta-III H.E. Project (Sikkim) were conducted on a geometrically similar comprehensive model built to scale of 1:40. The studies indicated that there was no vortex formation observed with reservoir levels ranging from 1588.0 m to 1568.0 m at discharges of 192.5 cumec and 175.0 cumec respectively. Sometimes intermittent, weak, circulatory flow was observed with reservoir levels ranging from 1565.0 m to 1567.0 m at discharges of 192.5 cumec and with reservoir level 1565.0 m to 1568.0 m at discharges of 175.0 cumec. Hydraulic performance of power intake was satisfactory with reservoir level 1563.0 m with both discharges.

(10) Model studies for Desilting Chamber of Teesta-III Hydro Electric Project (Sikkim)

82RR (H_2-06)

The hydraulic model studies for modified desilting chamber were carried out on a geometrically similar physical model built to scale 1:15 for Teesta Stage-III H.E. Project (Sikkim). The overall silt trapping efficiency of the desilting chamber for 2000 ppm sediment concentration with revised proposal of openings in the covering slab of flushing duct was observed to be 74.44%. The observed

silt trapping efficiency of the chamber for silt particles >0.2 mm size with revised proposal of openings was of the order of 93.38% for sediment concentration of 2000 ppm which seems to be sufficient. The dimension of the desilting chamber is adequate to remove the sediment of particle size >0.2 mm from the river flow. The overall flushing efficiency of the chamber is quite satisfactory as no opening was found chocked after experiments. No silt deposition was seen inside the flushing duct.

(11) Model studies for performance of power intake and reservoir sedimentation of Bajoli Holi Hydro Electric Project (HP)

82RR (H_2-07)

The hydraulic model studies to access the performance of power intake and sedimentation of reservoir were conducted on a geometrical similar model built to scale 1:40 for Bajoli-Holi HEP (Himachal Pradesh). The sill of power intake was found to be suitably located at El. 2000.00 m so as to provide the minimum submergence required as per IS9761-1995 (clause 5.2.2) and Gordon's criteria. No vortex formation was observed at any reservoir level at the mouth of intake. Also, the head losses through the intake were of the order of 0.30 m to 0.35 m as compared to the theoretical value of 0.281 m. As far as the reservoir sedimentation is concerned, under the ponded conditions 90% of sediment settles in the reservoir and less than 2% enters the intake. Even after continuous feeding of 3000 ppm sediment for 24 hours (corresponding to 6.32 days in proto), with intake drawing its designed discharge and rest of 500 cumec river inflow discharge passing through spillway, the deposited silt was about 6.30 m below the intake sill level.

(12) Model studies for Rongnichu Hydro Electric Project (Sikkim)

82RR (H_2-08)

Model studies were conducted for Barrage of Rongnichu HEP (Sikkim) on geometrically similar comprehensive model built to scale 1:30 and a TM No. 81 RR (H_2-10), October, 2010 was issued for the same. Further model studies of Barrage of Rongnichu HEP (Sikkim) on same model were conducted with revised layout of barrage having barrage axis shifted by 20 m towards upstream & rotating the axis by 10 degree (barrage downstream and intake upstream). The hydraulic test conducted on the model indicated that the waterway of the barrage with revised layout is quite adequate to pass the PMF and SPF at designed water level for respective discharges. Also, with one extreme right bay closed the SPF and PMF passed at levels below the designed level (Table No.1). The spillway rating curves as developed for free flow and gated conditions are shown in Drg. No. 9 & 10 respectively. Flow distribution across the barrage is more or less uniform with 30% discharge passing through undersluice bay and rest from the barrage bays. A residual velocity of the order of 4.59-5.29 m/sec was observed between end sill of stilling basin and trench weir at a discharge of 920 cumec.

(13) 2-D Model studies for sluice spillway of Nyabarongo HEP-Rwanda (East Africa).

82RR (H_2-09)

Model studies were conducted for spillway profile, breast wall profile and ski jump bucket of Nyaborongo H.E. Project, Rwanda (East Africa) on geometrically similar 2D-model built in a flume to the scale 1:20. The hydraulic tests results indicated that the proposed clear water way of 10.5 m with

spillway crest at El. 1476.0 m and breast wall at El. 1481.0 m (Drg-4) was observed to be adequate to pass the design discharge of 554.0 cumec (PMF) at reservoir El. 1487.5 m with all three bays fully opened and at 1497.5 m with only two bays fully opened. The observed spillway rating curves under gated condition are shown in Drg. No. 5 with all three bays operative and only two bays operative conditions respectively. A clear trajectory was formed by the proposed ski jump bucket.

(14) Model studies for spillway and power intake of Nyabarongo HEP-Rwanda (East Africa)

82RR (H_2-10)

Model studies were conducted for spillway and power intake of Nyabarongo H.E. Project, Rwanda (East Africa) on geometrically similar comprehensive model built to the scale 1:30. The observed hydraulic tests indicated that the proposed clear water way of 10.5 m of sluice spillway with spillway crest at El. 1476.0 m and breast wall level at El. 1481.0 m (Drg-6) is found adequate to pass the design discharge of 554.0 cumec (PMF) at reservoir El. 1487.7 m when all the three bays fully opened and at El. 1498.0 m with only two bays fully opened .The approaching flow conditions to the spillway structure were found more or less uniform at different discharges. The observed spillway rating curves when three and two bays are operative under free flow condition are shown in Drg. No.9. The trajectory was formed by the proposed ski jump bucket at all the discharges and raised to a maximum elevation 1486.0 m. at PMF when only two bays were operative. The impact of trajectory was observed at 40.0m.from bucket lip. Hydraulic behavior of intake and its sill level at El .1485.50 m. was found in order against air entrainment at MDDL and higher levels of the reservoir.

(15) Model studies for flood sluice of Hasan Dam (Republic of Yemen)

82RR (H_2-11)

Model studies were conducted for flood sluice of Hasan Dam project (Republic of Yemen) on a geometrically similar sectional flume model built to scale 1:30. The hydraulic tests conducted on the model indicated that the flood sluice provided is quite adequate to pass the discharge of 1750 cumec at reservoir level of 134.0 m. Rating curve for the flood sluice as developed for gated conditions is shown in Drg-5. 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 1750 cumec. Average residual velocity of the order of 6.83 m/sec was observed in d/s of the end sill of the stilling basin for a discharge of 1750 cumec. Profile of spillway and breast wall was observed to be alright as far as the development of pressure on the surface is concerned. Hydrostatic pressures on spillway and breast wall profile were observed as positive for all discharges. However, pressure on breast wall profile was observed as negative but within permissible limit.

(16) Model studies for reservoir flushing of Teesta-III Hydro Electric Project (Sikkim)

82RR (H_2-12)

The model studies for flushing of reservoir of Teesta-III H.E. Project (Sikkim) were conducted on a geometrically similar comprehensive model built to scale 1:40. The studies indicated that the hydraulic performance in respect of flushing of sediment was found satisfactory with both profiles (A & B) at respective discharges (200 & 300 cumec). A tendency of development of a deep channel at an EL 1540.0 m along the upstream face of the concrete face rock-fill dam (CFRD) was observed in all experiments.

It was observed that the deposited sediments on the side slope, which remained unaltered during the model experiments, would not stand vertically in the prototype and would get flushed out. Necessary measures may be taken to protect the upstream face of the dam upto EL 1535 m and the pocket between the upstream face of CFRD and the flushing tunnel intake left wall should be adequately protected for velocity upto 15 m/s which was observed in model. Periodic drawdown for sediment flushing during the monsoon or flood period may be adopted regularly to avoid consolidation of sediment deposits especially the cohesive clay deposits. Also minimizing water levels during monsoon or flood season will help to maintain sediment transport through reservoir.

(17) Compilation and analysis of observations recorded at meteorological observatory, Hydraulic Division-II, Bahadrabad.

82RR (H_2-13)

Various elements of meteorological observations such as temperature, relative humidity, rainfall, wind velocity, vapour pressure, sediment concentration and evaporation rate were observed at Meteorological Observatory, hydraulic Division-II, Bahadrabad in the year 2011. Maximum and Minimum temperature of the year was 39.6^0 C on 11-5-11 and 0.8^0 C on 24-12-11 respectively. Out of total 1321.9 mm rainfall of the year 2011, about 87.93% of total yearly rainfall was received from only June to September. The wettest month of the year was August 2011 in which 580.5 mm rainfall was observed. Total numbers of rainy days were 73. Max. average wind velocity was 5.5 km/hr on 18-4-11 and max. vapour pressure of 26.7 mm was observed on 23-6-11. Max. rate of evaporation, 8.5 mm/day, was observed on 11-5-11. A total evaporation loss during the year was 952 mm. Max. sediment concentration in the feeder channel of Research Station was observed as 3260 ppm on 2-8-11.

(18) Model studies for penstock bifurcation of Rampur Hydro Electric Project (HP).

82RR (H_2-14)

The physical hydraulic model study for penstock bifurcation of Rampur Hydro Electric Project (Himachal Pradesh) was conducted on a distorted model. At design discharge, the distribution of discharge among three pressure shafts were observed and found to be almost equal in the model. Also, 75% and 110% of the design discharge of 383.88 cumec was allowed to pass in the model and discharge distribution through the penstocks were found almost equal. Flow was observed almost streamlined in the model. No suppression of flow and formation of eddies was observed at y-junction in the model. Pressure under steady state condition with tailpool level 1010.0 m and 1024.0 m were found positive at all operating conditions. Maximum pressure of the order of 151.00 m and maximum pressure pulsation of the order of (+) 0.96 m was observed under steady state condition when one machine was closed and tailpool water level was maintained at 1024.0 m. Maximum hydrodynamic pressure of the order of 214.62 m was observed under load transient condition of 50% -100% - 0% when tailpool water level was maintained at 1010.0 m.

(c) HYDRAULIC DIVISION – III

(19) ANNUAL REPORT

82RR (H_3-01)

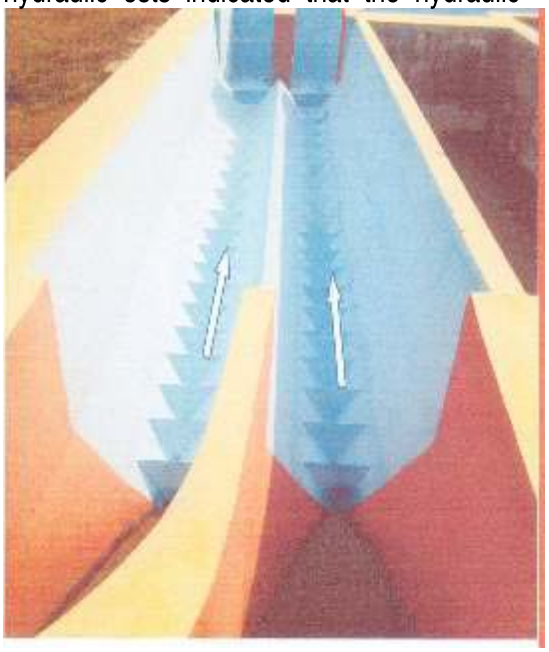
Hydraulic Division-III was established in May 1965, since then model studies pertaining to various hydraulic structures such as dams, diversion structures, spillways, outlets, intake of hydro-electric projects, desilting arrangements, canal and bypass for

power houses, surge tanks are being done. During the year 2011-12, three Technical Memorandums were issued which, have been briefly summarized as given below

(20) Model Studies for Desilting Chamber of Singoli- Bhatwari H.E. Project. (UTTARAKHAND)

82RR (H_3-02)

Model studies were conducted for proposed desilting chamber of Singoli- Bhatwari H.E. Project, on the existing geometrically similar model built to scale of 1:10. The observed hydraulic ests indicated that the hydraulic



design as evolved on mathematical model and tested on physical model was found in order. The sediment concentrations passing through HRT and flushing duct and grain size distribution of HRT sample were determined. From the observed ppm of collected samples, the efficiency of more than 72.0% and 96.0% were found in respect of sediment concentration (overall) and +0.3 mm particles size respectively at concentration of 1000 ppm to 5500 ppm. No remarkable sediment deposition was seen in desilting chamber and flushing duct.

(21) An Interim Report on Model Studies for Uniform Discharge Distribution through Tenga Dam Spillway of Kameng H.E. Project (Arunachal Pradesh).

82RR (H_3-03)

Further model studies were conducted for uniform discharge distribution through

Tenga dam spillway bays of Kameng H.E. Project (Arunachal Pradesh) on existing geometrically similar comprehensive model built to the scale 1:40. The observed hydraulic tests indicated that with only one spur at 98.9 m upstream of dam axis as proposed by sponsor (Drg-3), the discharge distribution through spillway bays is almost uniform upto 3000 cumec. The maximum water level (MWL) El.770.6 m was attained in the reservoir at a discharge of 3200 cumec while the dam overflowed at all the discharges more than 3500 cumec with spur at 98.9 m upstream of dam axis.

(d) HYDRAULIC DIVISION – IV

Annual Report of Hydraulic Division-IV.

Hydraulics Division-4, Irrigation Research Institute Roorkee conducts capacity survey and sedimentation studies of different

reservoirs in Uttarakhand and in other states too.

(e) GROUND WATER DIVISION- I

(22) Annual Report Ground Water Division-I

82RR (GW_1-01)

The studies and activities undertaken by the ground water division -1 during the year 2010-11 are documented in the report.

(23) Climate Change: An Overview

82RR (GW_1-02)

Climate change is a long-term change in statistical distribution of weather patterns over periods of time that range from decades to millions of year. It may be a change in the average weather conditions or a change in the distribution of weather events with respect to an average, for example, greater or fewer extreme weather events. Climate change may occur locally or across the globe. In recent usage, especially in the context of environmental policy, climate change usually refers to changes in modern climate. It may be called anthropogenic or global warming. In understanding climate change and its causes and is beginning to develop a strong understanding of current and potential impacts that will affect people today and in coming decades. This report is mainly based on articles published in newspapers, magazines and internet analysis.

(24) Application of Mathematical Modeling in Ground Water Management

82RR (GW_1-03)

Exploitation of ground water must be done optimally so that the abstraction may not exceed the net recharge. Aquifer modeling is a potential tool in studying aquifer response to spatio-temporal variation of input-output stresses and thus helps evolve appropriate groundwater management policies. Basic principles and essential steps for aquifer modeling are described in this report. Considering the paucity of reliable and representative data for aquifer modeling. The necessary data requirements have been elaborated. Salient features of aquifer modeling studies by digital model in selected areas using facilities established at the Irrigation Research Institute (IRI), have been outlined.

(25) Application of ANSYS in seepage analysis below the foundation of hydraulic structures.

82RR (GW_1-04)

Barrages are constructed on rivers to redirect the water from a river to water scarcity areas to meet out the mounting demand of water. Well defined criteria and techniques are on hand to design a Barrage. Experience has revealed that for sprouting well-organized and cost-effective design of Barrages, physical model studies are inevitable. Many a times it has been found that Barrage foundation include complicated boundary and hydrogeological conditions. It has been found that analysis of such Barrage foundations is tricky all the way through physical models, such as EHDA model. It has been found that 'ANSYS' software based on FEM plays a versatile role in seepage analysis in such cases. Moreover, it is quick, accurate, efficient and cost effective.

(f) GROUND WATER DIVISION- II

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

82RR (GW_2-01)

The studies and activities undertaken by the ground water division-2 during the year 2010-11 are documented in the report.

(27) A Compiled List of Technical Memorandums/Research Reports of Ground Water Div.-2 from 1955-56 to 2011-12.

82RR (GW_2-02)

The ground water division of IRI 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. Using the Electrical Analogy technique Seepage flow below the complicated hydraulic structures of irrigation projects is studied. In addition to this, Seepage losses from watercourses and minors by Ponding method are also estimated in canal lining laboratory so as to achieve safety optimization of the canal.

The results of all such research and development works are published in the form of Research Reports / Technical Memorandums. This report presents a compiled list of all Research Reports / Technical Memorandums published by the ground water division-2 from 1955-56 to 2011-12.

(28) Institute at a Glance during year 2000 to 2011.

82RR (GW_2-03)

Irrigation Research Institute, under the aegis of U.P. Irrigation Department took full fledged status as a Institute in the year 1954 in Roorkee. After completing 46 years (from 1954–October 2000) long glorious journey in the field of R&D activities of irrigation, flood control and hydroelectric projects, the institute has served and been serving the purpose for the development of country by way of providing consultancy, modeling and testing facilities in the field as well as in the laboratories to various States of India and Govt. of India Corporations.

The constitution of new born hill state Uttaranchal now Uttarakhand on 9th November 2000, the Institute has now taking a lead role under the guidance of Uttarakhand Irrigation Department. The challenges of the new state are also being tackled efficiently along with the other state problems related to Civil Engineering and River Valley Development Projects. The results of all such research and development works are published in the form of Research Reports and Technical Reports. The report prepared by the Institute from 1955 to 2002 was already presented in T. M. No. 74RR (B-10) in the year 12/2003. In the continuation, this report presents a compiled list of Research Reports, Test Reports and Research Papers presented by the Institute under state Uttarakhand from year 2000 to 2011.

(g) BASIC DIVISION

(29) Annual Report Basic Division

82RR (B-01)

The studies and activities undertaken by the Basic Division during the year 2010-11 are documented in the report. Besides, the vocational / summer training for engineering graduate students from various universities are coordinated.

(30) Weirs and Barrages in Uttarakhand – A data base in Arc-View

82RR (B-01)

Efficient management of water resources of the globe has been a matter of concern for engineers and planners of the countries. To fulfill the objectives, dams, weirs and barrages are constructed across the rivers. Depending upon the requirement and site suitability these dams vary in their sizes, height, types and material of construction etc and have different parameters to classify. In recent times G.I.S. (Geographic Information