सत्यमेव जयते

Government of India
Ministry of Water Resources,
River Development and Ganga Rejuvenation
(http://mowr.gov.in)

CWPRS Annual Report 2013-14

CENTRAL WATER AND POWER RESEARCH STATION
KHADAKWASLA, PUNE-411024, INDIA

ANNUAL REPORT 2013-14

CENTRAL WATER AND POWER RESEARCH STATION, PUNE

VISION

To build a World Class Centre of Excellence for research in hydraulic engineering and allied disciplines; which is responsive to changing global scenario, and need for sustaining and enhancing excellence in providing technological solutions for optimal and safe design of water resources structures.

MISSION

- ***To meet the country's need for applied and basic research studies in water resources, power sector and coastal engineering with world-class standards***
- ***To develop competence in deployment of latest technologies, and to undertake new areas of research to meet the future needs for development of water resources projects in the country.***
- ***To disseminate information, skills and knowledge for capacity-building and mass awareness***

OBJECTIVES

Conducting R & D studies in hydraulics and allied disciplines using one or combination of physical and mathematical modelling and field studies to:

- ***carry out applied research to solve specific real time problems for planning and development of water resources, river engineering, power and coastal projects***
- ***carry out necessary basic research for improving and introducing latest developments in the specific studies***
- ***disseminate research findings by publishing research papers and technical manuals, conducting training programmes, and delivering invited lectures***
- ***calibrate current/ flow meters, test soil/ rock/ concrete/ fine & coarse aggregate samples, and analyse water quality parameters***
- ***upgrade the research infrastructure through five year plans***

CONTENTS

FROM THE DIRECTOR'S DESK

It gives me immense pleasure in presenting the Annual Report for the year 2013-14, highlighting the activities and achievements of Central Water & Power Research Station.

As an apex body in hydraulic research in the country, CWPRS continues to provide R&D and consultancy support to a variety of projects using physical hydraulic models, mathematical models and field and laboratory experiments. With seven major disciplines under one umbrella, viz., River Engineering, River and Reservoir Systems Modeling, Reservoir and Appurtenant Structures, Coastal and Offshore Engineering, Foundation and Structures, Applied Earth Sciences, and Instrumentation, Calibration and Testing Facilities, CWPRS has distinct advantage while providing solutions to problems involving multiple disciplines.

The greatest asset CWPRS possesses is its highly-competent scientists and engineers with their extensive knowledge base, ingrained professionalism and resolute commitment. The basic, applied & result-oriented research and development programs are integrated and executed by very innovative, dynamic and focused team of scientists and engineers.

The need to adapt and acclimatize with the latest scientific/research developments is continuous and at CWPRS we appreciate this opportunity to endeavor further to provide service through research. We establish in-depth relationships with our clients by learning their environments & challenges so that we can offer tangible solutions with a sincere perspective.

The present Report provides an insight into the functions and activities of this organization and its contribution in the development and management of water resources, river training works, hydroelectric/ thermal/ nuclear power, and design of coastal and offshore engineering structures and port layouts.

During 2013-14, more than 112 applied research projects were completed in the areas of seven major disciplines of CWPRS. Under Instrumentation, Calibration and Testing Facilities, around 1031 different types of current meters have been calibrated. Gravimetric and volumetric calibration facilities conforming to ISO 4185 are available at CWPRS for calibration of flow meters, testing of filters and ascertaining flow valve characteristics under which 81 studies were conducted for various clients.

Dissemination of knowledge & research findings is a significant mandate of CWPRS. CWPRS officers published a total of 60 research papers in different journals and seminars/symposia/conferences and participated in 33 technical events. 11 training programs

were organized on specialized topics, in addition to delivering 68 invited lectures at different organizations. Glimpses of these institutional activities may be seen in the report.

As is the case every year, the institution had a galaxy of visitors during 2013-14. Use of official language Hindi is pursued and encouraged resolutely on a day-to-day basis. Hindi Pakhwada was organised at CWPRS during 1-14 September 2013 to encourage accelerated use of Hindi in official communications; with 14th September 2013 celebrated as Hindi day.

I hope the report would provide the nuclear glimpses of activities of CWPRS.

S. GOVINDAN

ABOUT THE INSTITUTE

General

The Central Water and Power Research Station (CWPRS), Pune, established in 1916 by the then Bombay Presidency as a Special Irrigation Cell, is the leading national hydraulic research institute under the Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR, RD&GR), New Delhi. In its early days of formation, this institute played important role by conducted outstanding research work for the Sukkar Barrage in Sind, the largest irrigation project in the world (1927 to 1932). Recognizing its role in the systematic study of various phases of water flow, including floods, the institution was taken over by the Government of India in 1936. With the dawn of independence, and launching of planned development of water resources of the nation, CWPRS became the principal central agency to cater to the research and development (R&D) needs of hydraulics and allied disciplines for evolving safe and economical designs of hydraulic structures involved in water resources projects, river engineering, power generation and coastal engineering projects. The research activities at CWPRS can be grouped into seven major disciplines as listed below.

- River Engineering
- River and Reservoir Systems Modelling
- Reservoir and Appurtenant Structures
- Coastal and Offshore Engineering
- Foundation and Structures
- Applied Earth Sciences
- Instrumentation, Calibration and Testing Facilities

Advisory services are offered to the government within the sphere of its activities by participation in various expert committees. The solutions offered by CWPRS are based on the investigations from physical and mathematical models, field investigations coupled with desk studies or from a combination of these. The institution also carries out collection and analysis of field/ prototype data on a variety of engineering, hydraulic and environmental parameters. Disseminating the research findings amongst hydraulic research fraternity, and promoting research activities at other institutions by imparting training to their research manpower, are also undertaken.

Today, as a part of the Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR, RD&GR), the mandate of the institution encompasses undertaking specific research studies supported by necessary basic research. Comprehensive R&D support is offered to a variety of projects in fields as diverse as river training and bank protection measures, hydraulic design of bridges and barrages, flood forecasting, dam break analysis, water quality analysis of river and reservoir systems, design of spillways and energy dissipators, analysis of water conductor and tail race system, optimization of the design and layout of ports and harbours suggesting coastal protection measures based on locally available materials, investigations for foundations of hydraulic structures, analysis of structures subjected to various static and dynamic loads, applied earth sciences studies for the sites of hydro-electric and other projects, calibration of currentmeters and flow meters, testing of pumps and turbines and instrumentation for dams.

CWPRS campus, situated downstream of Khadakwasla dam in south westerly part of Pune, occupies an area of about 400 acres, where major research infrastructure available include: water re-circulation system for physical models, workshop, library, computers and communication facilities, auditorium and housing facilities. CWPRS has been recognized as the regional laboratory of the Economic and Social Commission for Asia and the Pacific (ESCAP) since 1971. The institution, with multi-disciplinary approach in its activities, thus represents unique services available to the country and the ESCAP region.

Organizational Set-up

CWPRS is a subordinate office of MoWR, RD&GR. The Director is the Head of the Organization. Joint Director is the group leader of the discipline of research. The Chief Administrative Officer is designated as the Head of Office. The total sanctioned staff strength of CWPRS is 1,131. The research cadre, comprising of Chief Research Officer (CRO), Senior Research Officer (SRO), Research Officer (RO), Assistant Research Officer (ARO) and Research Assistant (RA) has a sanctioned strength of 358 personnel. The other supporting staff includes technical, auxiliary technical, administration, accounts and ancillary services. The Governing Council (GC), under the Chairmanship of the Secretary, MoWR, and the Technical Advisory Committee (TAC) under the Chairmanship of the Chairman, Central Water Commission render advice to the Ministry regarding functioning of CWPRS.

Governing Council

The GC functions as an overall policy making body for CWPRS under the Chairmanship of the Secretary, MoWR, RD&GR. The GC comprises members from the Finance and Administrative Wings of MoWR, Planning Commission, User Organizations, State Governments and Non-Government Officials. Apart from laying down broad policy guidelines, the GC monitors the overall progress and performance of the institution. Other functions of GC include scrutiny and monitoring of expansion programmes, annual and five-year plans, budgetary allocations, creation and abolition of work disciplines, review of manpower requirements and delegation of additional powers.

Technical Advisory Committee

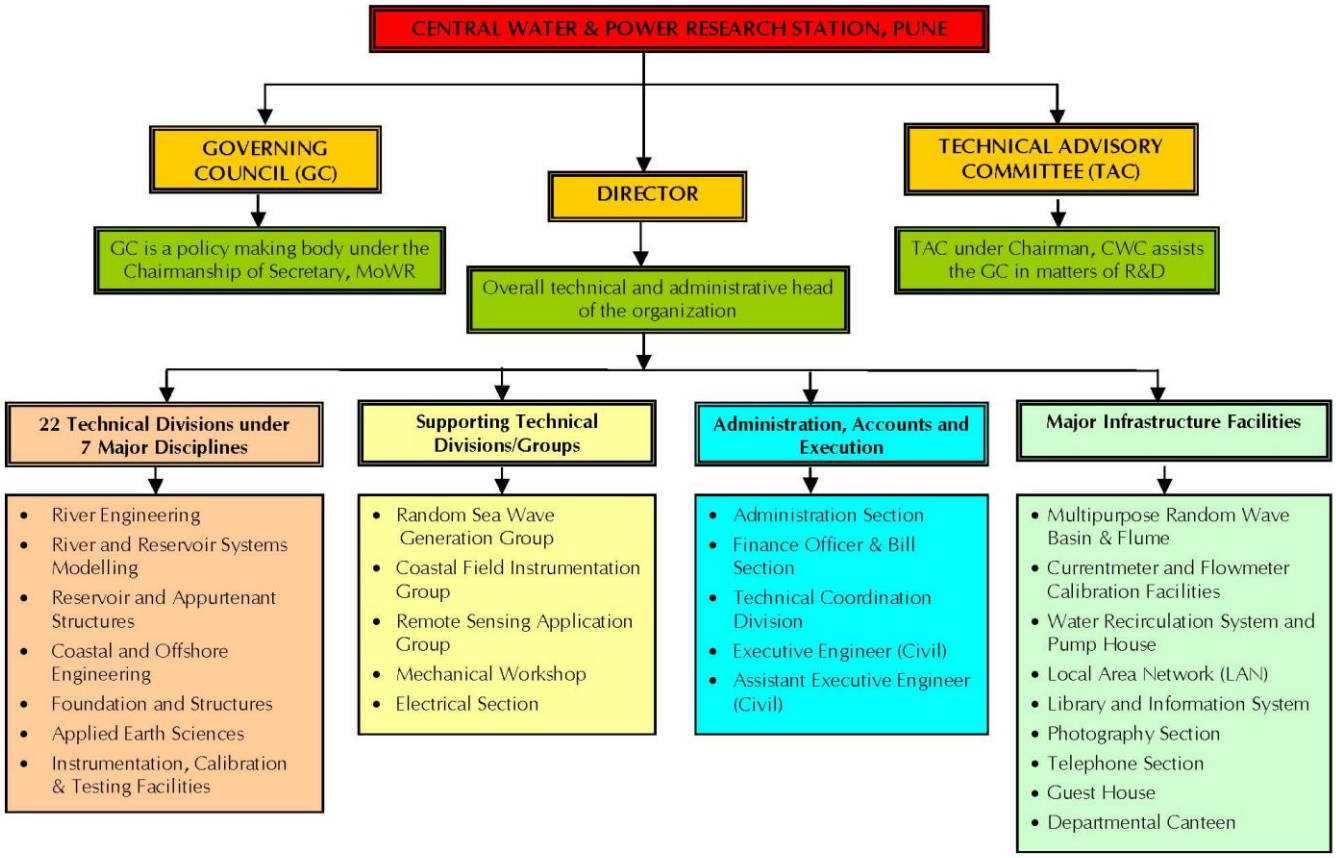
The TAC, chaired by the Chairman, Central Water Commission, is primarily intended to assist the GC in the matters of R&D and associated technical programmes. The Committee, inter alia, scrutinizes and recommends the expansion and research proposals under the five-year plans, suggests programmes for training of manpower and provides guidance in formulation of collaborative arrangements and Memoranda of Understanding with other agencies/ institutions.

Budget and Programme Committee

The Budget and Programme Committee (BPC) assists the GC in formulation of budget proposals. The terms of reference of the Committee include: monitoring progress in implementation of the approved programmes and utilisation of the sanctioned budget, and linking programmes and budget closely so as to facilitate preparation of a proper performance budget. The Director, CWPRS, is the chairperson of the BPC; with the Finance Officer being the Member Secretary.

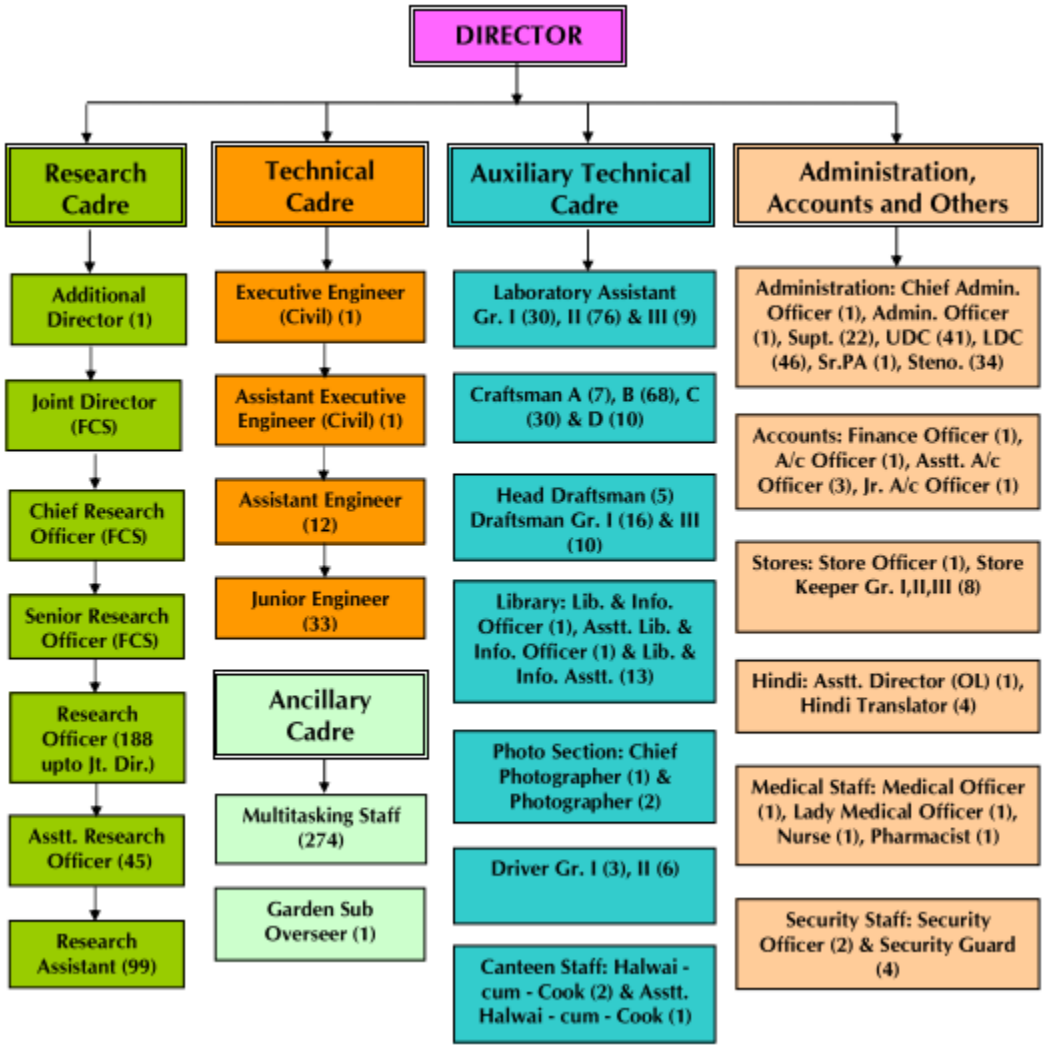
PART-I
GENERAL

ORGANIZATIONAL SETUP



ORGANIZATIONAL CHART

CENTRAL WATER AND POWER RESEARCH STATION, PUNE



BUDGET AND FINANCE

1. Plan Schemes

The main purpose of Plan Schemes is to develop and strengthen the research infrastructure at CWPRS for serving the nation through research more efficiently and effectively. The following schemes were under implementation at the institution during 2013-14.

No.	Name of the scheme	Final Estimate 2013-14 (₹ lakh)
A)	XIth Plan - R&D in Apex Organizations under MoWR– CWPRS component	900.00
B)	Hydrology Project II	161.50

During 2013-14, the following important activities were undertaken under the above-mentioned schemes.

A) XIIth Plan - R&D in Apex Organizations under MoWR– CWPRS Component

- Civil Works: Providing, Installation and commissioning of electrically actuated butterfly valves at HMC Division (₹ 0.64 Crore), Water Recirculation System (₹ 0.39 Crore), Renovation of various office-cum-laboratory buildings, boundary wall, roads, special repairs to residential and office buildings, sewage lines and horticulture works, etc. (₹ 2.71 Crore), Electrical Infrastructure (₹ 0.48 Crore), Renovation of residential quarters E-type, D-Type and C-Type (₹ 0.64 Crore), Spillway model for Basic Research (₹ 0.10 Crore)

- Machinery & Equipment: Mathematical Modeling Software-Procurement of software's Flow-3D (₹ 0.95 Crore), Procurement of equipment for enhancing research facilities for VT / HAPT / HM /SMD /GP/Library and others (₹ 0.63 Crore), Up-gradation and modernization of research facilities for Seismological Division (₹ 0.64 crore), Procurement of LAN switches and AMC of PCs, servers, LAN, UPS, Silicon Graphics Workstation etc. (₹ 0.12 Crore), Procurement of several advanced machinery and equipments (₹ 0.41 Crore)

B) Hydrology Project II

- CWPRS is performing the role of a facilitator in R&D, training, and studies involving special technical support within the overall framework of World Bank aided Hydrology Project-II, which commenced in April 2006, and is planned to continue till May 2014. The Purpose Driven Study entitled "Optimization of Gauge Discharge Network in Upper Bhima Basin" was continuing during the year. CWPRS also worked on building up its capacity for development of sustainable Decision Support System (DSS) for Water Resources Management and Planning Applications.

With an outlay of 1.62 Crore during 2013-14, the following major activities have been undertaken under the CWPRS component of HP-II

- Procurement of office/ training equipment for institutional strengthening
- Training of CWPRS personnel on DSS-P generic model, developed by the consultants; providing technical assistance to states for customization of the generic DSS(P) model

- Upgradation of research facilities at CWPRS such as Supervisory Control And Data Acquisition (SCADA), Civil works for upgradation of model canal etc.
- Completion of civil works related to Modernisation of Library Building, Renovation of VIP suites in Guest House, Renovation of Conference Hall and Up-gradation of two Lecture Halls
- Research Activities - Hydrographic survey for Tawa reservoir CWPRS completed field survey jointly with the WRD officials of Govt of Madhya Pradesh

2. Non-Plan Budget

The non-plan budget and expenditure details for the year 2013-14 are given below.

Item/ Head	2013-14 (₹ Crore)		
	Budget Estimate	Revised Estimate	Actual
Salary	48.00	48.60	48.25
Non-Salary	2.60	2.59	2.44
Total (Gross)	50.60	51.19	50.69
Recovery	6.50	6.50	9.48
Net	44.10	44.69	41.21

STAFF WELFARE ACTIVITIES

1. Minority Welfare

The recruitment of personnel from minority community, and representation of minorities in Selection Committees/ Boards is monitored in accordance with guidelines issued by the erstwhile Ministry of Welfare (present Ministry of Social Justice & Empowerment) in March 1990.

2. Monitoring of Reservation for Physically Handicapped

Monitoring of the recruitment of physically handicapped persons is being done to ensure fulfillment of three percent quota, as stipulated. At present, a total of 33 persons with disabilities are working in the Research Station with 3, 7 and 24 in group A, B and C, respectively. Benefits earmarked like Transport Allowance, Concessions regarding Recruitment fees, Professional Tax exemptions etc. are provided as per Government instructions. Slope ladders and special washrooms are being provided in the Research Station wherever possible.

3. Monitoring of Reservation for SC/ ST/ OBC

Monitoring of the recruitment of candidates from SC/ST/OBC category is made following the guidelines issued from time to time. Shri R.K. Kamble, Joint Director, guides the overall matters in this regard as Liaison Officer. A summary of posts filled from SC/ST/OBC/PH categories are given below.

Group	Position as on 31st March 2014				
	SC	ST	OBC	PH	UR
A	28	07	17	02	98
B	36	07	16	06	159
C	87	39	35	20	293
Total	151	53	68	28	550

4. Preservation and Enforcement of Right to Gender Equality of Working Women

There are five-members in the committee for preservation and enforcement of right to gender equality of working women; with the composition of the committee as per the guidelines issued by the Honourable Supreme Court of India. Dr. (Mrs.) V V Bhosekar, Joint Director is the Chairperson of the committee. Meetings of the committee are held regularly. One complaint was received, and the same was disposed off by the committee during 2013-14.

5. CWPRS Staff Colony Welfare Committee

The CWPRS Recreation Club has been constituted to provide facilities for the staff members to promote social, recreational and friendly relations amongst its members to foster unity and fellow feelings to provide facilities for physical, cultural, intellectual and recreational and other activities that are open to all the members from time to time. All the employees of the CWPRS are eligible to become members of the club on their own by paying annual subscription of Rs. 25/-. Every year the Recreation Club provides cultural and recreational activities to the members by arranging excursion trip in and around Pune, sports, lectures and other activities throughout the year.

Health is Wealth. Keeping this in mind, the CWPRS Recreation Club had arranged lectures of famous and eminent persons such as

- Lecture on `Glucoma and other eye related problems' by Dr. Mrs. Savita Bhat, Vasan Eye Care on 13.9.2014
- An Eye Check-up Camp was organized at CWPRS on 25.10.2014. Nearly 450 persons (officers and staff members) took advantage of the camp.
- Lecture on `How to preserve the Indian Culture' by Samajbhusan Dr.Laxman Mahadev Apte, Founder Chairman, Kamdenu Trust on 25.2.2014.
- Lecture on Diabetes and related diet by Dr. Harshe, Diabatologist, Poona Hospital was organized on 7.3.2014.

The above lectures received overwhelming response from CWPRS officers and staff members.

The Recreation Club had arranged `Til Gul Samaramb' on 16.1.2014 on the occasion of Makara Sankranti to bring all the employees together. The Club organized various in-house sports for its members. Ladies and Gents participated in large numbers and won prizes. A variety entertainment programme was held by the Colony Welfare Committee to celebrate 26th January 2014 on account of Republic Day and CWPRS Recreation Club had taken active part and sponsored prizes to the winners. The Club had also actively participated in the Shiv Jayanti Programme organized by the Kamgar Sabha at CWPRS on 22.2.2014. Keeping in view the reading interest of its members, the Recreation Club made available to its readers from the CWPRS Recreation Club Library for the year 2013-14.

As a part of the concluding activity of CWPRS Recreation Club an Annual Day function by the Recreation Club was organized on 29th March 2014. A Musical Orchestra was arranged on 29.3.2014 on account of Annual Day. Prizes were distributed to the winners of the various sports and cultural events organsed by the Recreation Club for the year 2013-14 at the hands of the Chairman, Recreation Club.

Blood donation camp was arranged at CWPRS on 28th June 2013

VIGILANCE AND DISCIPLINARY CASES

The vigilance / disciplinary cases, and related complaints concerning officers and staff of CWPRS, received prompt attention during 2013-14. Break-up of vigilance and disciplinary cases in respect of different categories of staff, as on 31st Mar 2014, is given below in Tables I and II respectively.

Table I: Vigilance cases

No.	Particulars	Group A &B	Group C
1	No. of cases pending in the beginning of the year	0	0
2	No. of cases added during the year	12	0
3	No. of cases disposed off during the year	6	0
4	No. of cases pending at the end of the year	6	0

Table II: Disciplinary cases where the Director, CWPRS is the disciplinary authority

No.	Particulars	Group A	Group B	Group C
1	No. of cases pending in the beginning of the year	0	1	2
2	No. of cases added during the year	0	0	0
3	No. of cases disposed off during the year	0	0	2
4	No. of cases pending at the end of the year.	0	1	0

RTI ACT, GRIEVANCE REDRESSAL MECHANISM AND CITIZEN'S CHARTER

1. RTI Act

Under the provisions of Section 4(b) of RTI Act 2005, manual giving suo-moto information on CWPRS has been published in the website www.cwprs.gov.in as a part of implementation of the act. The manual is periodically being updated. Further, all efforts are being taken to administer and implement the act. The citizens are also given guidance in obtaining information under the act. The names, addresses and other details regarding the Appellate Authority and Public Information Officer are given below.

Appellate Authority: Shri S. Govindan, Director, CWPRS, Pune 411024;
Tel.: 020-24380552 (Office); 020-26687748 (Residence)

Public Information Officer: Shri R.K. Kamble, Joint Director, CWPRS, Pune 411024;
Tel: 020-24103411 (Office); 020- 24224375 (Residence)

Information on requests and appeals handled under the act during 2011-12 is summarized below.

	Opening balance (as on 1st Apr 2013)	Received during the year (including cases transferred to other Public Authorities)	No. of cases transferred to other Public Authorities	Decisions where requests/ appeals rejected	Decisions where requests/ appeals accepted
Requests	3	95	0	0	92
First Appeal	0	0	0	0	0
Charges Collected (Rs)					
Registration fee	Additional fee & other charges				Penalty ₹
₹750/-	₹350/-				0

2. Grievance Redress Mechanism

A Grievance Cell under the Chairmanship of Shri T. Nagendra, Joint Director, functions with the objective of looking into the grievances and for their settlement. The relevant data pertaining to cases handled during 2013-14 is given below:

Grievance cases pending as on 31st March 2013	1
Cases received during 2013-14	26
Cases disposed off during the year	13
Cases pending on 31st March 2014	14

The Centralised Public Grievance Redress and Monitoring System (CPGRAMS), the web based portal that enables an Indian citizen to lodge a complaint from anywhere and anytime directly, has been implemented at CWPRS. Periodical updating of the entries are being carried out and relevant reports are submitted.

3. Citizen's Charter

The Citizen's Charter in respect of CWPRS, formulated by a Task Force specially constituted for the purpose, has been subsequently upgraded/ revised/ modified in pursuance of related instructions/ communications from the Ministry from time to time, including the 7- step model for `Sevottam for Citizen Centricity in administration' as per relevant instructions of DARPG. The main components of the Citizen's Charter include: Vision and mission statement, details of business transacted and customers/ clients, services provided by the organisation, details of grievances redress mechanism in place and expectations from clients. Presently the Charter is in the process of getting formal approval from MoWR.

IMPORTANT VISITORS

Visit of Hon'ble Retd. Justice of Supreme Court Shri M.K. Sharma, alongwith Members of Vamshadhara Water Dispute Tribunal. 4th-5th May 2013

Visit of Prof. K.G. Rangaraju, National Review Committee, 3-4th June 2013

Visit of Dr. T.I. Eldho, IIT Bombay, Performance Evaluation Committee, 4th July 2013

Visit of Shri Harish Rawat, Hon'ble Union Minister of Water Resources on 10th July 2013

Visit of Air Vice Marshal P. P. Khandekar, Commandant and Director MILIT, Girinagar, Pune on 18h October 2013

Visit of Shri Ashok Gupta, Director (E-II), MoWR on 3rd March 2014

IMPORTANT EVENTS

- Dr. I.D.Gupta, Director and Shri M.N. Singh, Joint Director attended the inaugural function of "India Water Week" held at Vigyan Bhawan, New Delhi on 08 April 2013

- A Workshop on "Rain Water Harvesting and Water Conservation" was held on 09.07.2013 at CWPRS, Pune on account of Water Conservation Year 2013

- "Open House Day" was celebrated on 29th November 2013 at CWPRS. All officers and staff members contributed their mite with zeal and enthusiasm and presented the models / facilities in an elegant and admirable manner with proper illustration and made the "Open House Day" a successful event to achieve the desired goal of showcasing the contribution of CWPRS for ensuring mass awareness on Water Conservation

- 25th National Road Safety Week was observed at CWPRS, Pune during 11.01.2014 to 17.01.2014

- "Productivity Week 2014" was observed at CWPRS during 12 – 18 February 2014. The Productivity Week 2014 was celebrated through a series of programmes so as to develop creativity and spirit of work culture among the employees to enhance the productivity of the Research Station

- International Trade Fair (IITF 2013) was held during 14-27 November 2014 at Pragati Maidan, New Delhi

"Water Conservation Year" was celebrated on 9th July 2013

"Open House Day" was celebrated on 29th November 2013

राजभाषा हिन्दी के प्रगामी प्रयोग से संबंधित प्रमुख गतिविधियाँ

इस अनुसंधान शाला में कार्यालयीनकामकाज में हिन्दी के प्रगामी प्रयोग से संबंधित गतिविधियों के बारे में निम्नानुसार जानकारी प्रस्तुत है :

हिन्दी दिवस तथा हिंदी पखवाड़ा

अनुसंधान शाला में 14 सितम्बर 2013 को हिन्दी दिवस मनाया गया । इस अवसर पर मुख्य अतिथि अनुसंधान शाला के निदेशक, डॉ. ईश्वर दत्त गुप्ता थे । प्रति वर्ष की भांति इस वर्ष भी हिंदी पखवाड़े के दौरान राजभाषा कार्यान्वयन समिति के मार्गदर्शन में हिन्दी निबंध, वाद-विवाद, वार्तालाप, प्रश्न-मंच, प्रस्तुतीकरण, हिन्दी टंकण तथा तकनीकी कार्य में हिन्दी का प्रयोग आदि प्रतियोगिताओं का आयोजन किया गया। इन प्रतियोगिताओं में संस्था के अधिकारियों एवं कर्मचारियों ने उत्साह से भाग लिया । भारत सरकार द्वारा लागू मूल रूप में हिन्दी टिप्पण आलेखन पुरस्कार योजना अनुसंधान शाला में लागू की गई थी । इन प्रतियोगिताओं में योग्यता प्राप्त अधिकारी एवं कर्मचारीयोन्को मुख्य अतिथि के करकमलों द्वारा नकद पुरस्कार एवं प्रमाणपत्र देकर प्रोत्साहित किया गया ।

हिन्दी पत्रिका जलवाणी का प्रकाशन

हिन्दी दिवस के अवसर पर निदेशक महोदय के करकमलों द्वारा अनुसंधान शाला की हिन्दी गृह पत्रिका जलवाणी के बीसवें अंक का विमोचन किया गया । अनुसंधान शाला के अधिकारियों एवं कर्मचारियों ने उक्त पत्रिका में विभिन्न विषयों पर लेख लिखकर अपना योगदान दिया है ।

जलवाणी के बीसवें अंक का विमोचन करते हुए निदेशक डॉ. ईश्वर दत्त गुप्ता

अंग्रेजी हिन्दी तकनीकी शब्दावली का प्रकाशन

अनुसंधान शाला में प्रतिदिन के कार्य में प्रयोग आनेवाले तकनीकी शब्दों को एकत्रित करके आकृति एवं चित्रों को संलग्न कर एक पुस्तिका के रूप में छपवाया गया है । इस अवसर पर इस पुस्तिका का विमोचन भी निदेशक, डॉ. ईश्वर दत्त गुप्ता के कर कमलों द्वारा किया गया ।

हिन्दी कार्यशाला का आयोजन

वार्षिक कार्यक्रममें दिये गए निर्देशों के अनुसार अनुसंधान शाला में निम्नांकित तारीखों को हिन्दी कार्यशालाएँ आयोजित की गई :

अ.क्र.	अवधि	श्रेणी	अधिकारियों संख्या
1.	24.10.2013	अनुसंधान अधिकारी - 3 अनुसंधान सहायक - 9	12
2	04.02.2014	अनुसंधान अधिकारी - 6 सहायक अनु अधिकारी - 2 अनुसंधान सहायक - 1	9

प्रशिक्षण कार्यक्रम में संघ की राजभाषा नीति, सरकारी पत्राचार के नमूने, टिप्पण-आलेखन एवं भाषा और वर्तनी के बारे में उपयोगी सामग्री उपलब्ध कराई गई । उपस्थित सभी प्रतिभागीयोन्को कार्यशाला पुस्तिका भी वितरित की गई, जिसमें कार्यालयीन उपयोग से संबंधित जानकारी जैसे वाक्यांश, पदनाम, नेमी किस्म के पत्रों के नमूने, छुट्टी के आवेदन आदि सम्मिलित हैं । उपस्थित प्रतिभागियों ने कार्यशाला की उपयुक्तता के बारे में अपनी अनुक्रियाएँ (फीड बैक) प्रस्तुत की ।

कंप्यूटरों में हिंदी साफ्टवेयर

अनुसंधान शाला के सभी संगणकों में हिन्दी सॉफ्टवेयर लगवाए गए हैं जैसे iLeap, ISM Office, ISM Publisher और iTranslator इत्यादि । यूनिकोड आधारित सॉफ्टवेयर ISM V6 नेट वर्ज़न खरीद कर प्रयोग में लाया जा रहा है ।

हिन्दी वेबसाइट

इस अनुसंधान शाला की वेबसाइट www.cwprs.gov.in बनाई गई है जिसमें संस्था के बारे में जानकारी हिंदी में उपलब्ध कराई गई है। इसका समय-समय पर अद्यतन किया जाता है ।

अनुसंधान शाला के इन्ट्रानेट पर हिन्दी में नेमी प्रपत्र /मानक मसौदे उपलब्ध कराना

प्रतिदिन काम आनेवाले नेमी किस्म के प्रपत्र, मानक मसौदे जैसे आकस्मिक छुट्टी के आवेदन, कार्यग्रहण रिपोर्ट, प्रस्थान रिपोर्ट, प्रभागों/अनुभागों के नाम, मंत्रालयों/विभागों के नाम, छुट्टियों के प्रकार, वर्तनी, संदेश, गृह पत्रिका जलवाणी का बीसवाँ अंक, हमेशा प्रयुक्त होने वाले वाक्यांश आदि इन्ट्रानेट पर हिन्दी में उपलब्ध कराए गए हैं । साथ ही अनुसंधान शाला द्वारा सभी प्रयोगशालाओं की तकनीकी अंग्रेजी-हिन्दी शब्दावली भी उपलब्ध कराई गई है ।

हिन्दी में कार्य के लिए अनुभागों का नामांकन

निम्नांकित प्रभागों / अनुभागों में कार्य की कुछ मदें हिन्दी में करने के लिए विनिर्दिष्ट की गई है

अ.क्र.	प्रभाग / अनुभाग	प्रभाग द्वारा किए जाने वाले कार्य
1.	प्रशासन	• समूह "क" "ख" और "ग" के कर्मचारियों की सेवा पुस्तिकाओं में प्रविष्टियां • छुट्टियों के कार्यालय आदेश • आवधिक वेतन वृद्धि के प्रमाणपत्र • छुट्टी यात्रा रियायत अग्रिम का आदेश

		• वेतन नियतन के कार्यालय आदेश • सेवा निवृत्ति के आदेश • कर्मचारियों की वरिष्ठता सूची • आवास आबंटन की अग्रता सूची • दौरा अग्रिम के आदेश • कुछ फाइलों में टिप्पण आलेखन
2.	प्रशासन (नियमित औद्योगिक स्थापना)	• कर्मचारियों की सेवा पुस्तिकाओं में प्रविष्टियां • छुट्टियों के कार्यालय आदेश • आवधिक वेतन वृद्धि के प्रमाणपत्र • कर्मचारियों को ज्ञापन • छुट्टी यात्रा रियायत अग्रिम का आदेश • वेतन नियतन के कार्यालय आदेश • सेवा निवृत्ति के आदेश • कर्मचारियों की वरिष्ठता सूची • कुछ फाइलों में टिप्पण आलेखन
3.	बिल अनुभाग	• द्विभाषी वेतन पर्ची • चिकित्सा अग्रिम के आदेश • चिकित्सा अग्रिम से संबंधित जाँच सूची • दौरा अग्रिम के आदेश
4.	अधिशासी अभियंता (सिविल) का कार्यालय	• बेबाकी प्रमाण पत्र • चेकों के अग्रेषण पत्र • प्राप्त हुए भुगतान की पावती
5.	तटीय इंजीनियरिंग के लिए गणितीय प्रतिमानन (संगणक)	• तकनीकी रिपोर्टों के सारांश तथा अन्य कार्यों में यथा संभव हिन्दी का प्रयोग किया जाता है।
6.	नदी जलगति विज्ञान	• तकनीकी रिपोर्टों के सारांश तथा अन्य कार्यों में यथा संभव हिन्दी का प्रयोग किया जाता है। • जलवाणी में लेख लिखकर कर्मचारियों का योगदान
7.	जल गुणवत्ता विश्लेषण तथा प्रतिमानन	• तकनीकी रिपोर्टों के सारांश तथा अन्य कार्यों में यथा संभव हिन्दी का प्रयोग किया जाता है।

नियम 8(4) के अधीन हिन्दी में कामकाज

अनुसंधान शाला के 10 अधिकारियों/कर्मचारियों को राजभाषा नियम 1976 के नियम 8(4) के अधीन टिप्पण प्रारूपण और ऐसे अन्य शासकीय प्रयोजनों के लिए केवल हिन्दी का प्रयोग करने के लिए दिनांक 14.8.2003 के आदेश संख्या 675/6/2003-हिन्दी द्वारा नामित किया गया है।

तकनीकी काम में हिन्दी का प्रयोग

अनुसंधान शाला के विभिन्न प्रभागों/अनुभागों द्वारा किए जाने वाले अध्ययनों के आधार पर परियोजना प्राधिकारियों को भेजे जाने वाली तकनीकी रिपोर्टों के सारांश, अग्रेषण पत्र, रेपोर्ट प्रलेख पत्र, सार, प्राक्कलन, विषय सूची आदि मदें अंग्रेजी के साथ अनिवार्यत: हिन्दी में भी भेजने हेतु अनुरोध किया गया है।

PART-II
RESEARCH AND DEVELOPMENT

BACKGROUND

CWPRS is mainly engaged in project specific research to evolve safe and cost-effective designs of hydraulic structures involved in development of water resources, river engineering, power plants, and coastal engineering projects. Physical and mathematical model studies coupled with field and laboratory experiments are carried out for this purpose in the seven major areas of expertise of CWPRS as follows :

1. River Engineering: River Engineering mainly deals with river training and bank protection works, hydraulic design of barrages and bridges, and location and design of water intakes using morphological studies. Field studies for measuring water and sediment discharge in rivers and canals are also conducted.

2. River and Reservoir Systems Modelling: Hydrologic and meteorologic studies are conducted to estimate extreme values of various parameters such as rainfall, temperature and humidity. Flood estimation and forecast, reservoir sedimentation and water quality studies are carried out using mathematical models and field surveys.

3. Reservoir and Appurtenant Structures: Spillways and Energy Dissipators are studied on physical models. Water conductor systems including head race and tail race channels/tunnels and surge shafts are studied on both physical and mathematical models. Studies are carried out on physical models for desilting basins, sedimentation and flushing through reservoirs, sediment exclusion devices. Sedimentation in reservoirs is also assessed through remote sensing.

4. Coastal and Offshore Engineering: This discipline deals with optimization of location, length and alignment of breakwaters, jetties, berths, approach channel, turning circle etc. for development of ports and harbours. Estimation of siltation in harbours, their disposal and sand bypassing, location of sand trap and hot water recirculation studies are carried out using both physical and mathematical models. Suggesting suitable coastal protection measures based on locally available materials is an important activity of the group.

5. Foundation and Structures: Laboratory and field tests are carried out to determine soil, rock and concrete properties. Mathematical modelling as well as experimental studies are conducted for studying the stability and structural safety of dams and appurtenant structures. Field studies are carried out for assessing the health of hydraulic structures and suggesting suitable repairing measures.

6. Applied Earth Sciences: Seismic surveillance of river-valley projects, assessment of site-specific design seismic parameters, controlled blasting studies for civil engineering construction sites, evaluation of quality of concrete and masonry is done by non-destructive methods and estimation of elastic properties for foundation of massive structures for geophysical methods are the main activities of this group.

7. Instrumentation, Calibration and Testing Facilities: Hydraulic Instrumentation is used for data collection on physical hydraulic models. Field data collection is carried out on coastal parameters like water level, velocity, wave-height etc. A Random Sea Wave Generation (RSWG) system is used for wave flumes and basins. Dam instrumentation is provided on prototype. Current meter and flow meter calibration facilities are also available, which are used extensively.

This section first gives the list of 112 technical reports submitted during the year, and then presents the summaries of the studies carried out in the above seven disciplines.

LIST OF TECHNICAL REPORTS SUBMITTED

Sl. No.	Title	Report No	Month/Year
1.	Mathematical model studies for various flow training measures to improve the navigation channel leading to Haldia dock in Hugli Estuary, West Bengal for KoPT	5058	04/2013
2.	Mathematical model studies for hydrodynamics siltation/ morphological changes and dispersion during dredging and disposal for proposed development multipurpose terminal at Karanja creek, Navi Mumbai	5059	04/2013
3.	Permeability of cores from upstream face gunitting of Dimbhe dam, Maharashtra	5060	04/2013
4.	Hydraulic model studies for reservoir sedimentation and flushing for Luhri H.E. Project, Himachal Pradesh	5061	04/2013
5.	Non-Destructive studies for assessment of quality of in-situ concrete of 25 MW T.A. Foundation of Unit No.6, Rourkela Steel Plant, Sail, Odisha	5062	04/2013
6.	Estimation of site-specific seismic design parameters for Kundalia Major multipurpose project M.P.	5063	04/2013
7.	Estimation of site-specific seismic design parameters for Mohanpura Major multipurpose project M.P.	5064	04/2013
8.	Physical model studies for wave tranquility for the proposed development of western dock at Paradip Port, Orissa	5065	04/2013
9.	Mathematical model studies for the proposed development of western dock at Paradip Port, Orissa	5066	04/2013
10.	Mathematical Model studies for tidal hydrodynamics and siltation for the proposed development of Western Dock at Paradip Port, Odisha	5067	04/2013
11.	Studies for location and type of intake for proposed super thermal power project near Darlipali, Orissa	5068	04/2013
12.	Wave flume studies for the restoration of damaged sourth breakwater at Paradip Port, Odisha	5069	04/2013
13.	SECRET REPORT - Desk studies for ship motions for Phase II development of project seabird, Karwar	5070	04/2013
14.	Mathematical model studies for wave tranquility for the development of Fish Boat Landing Facility at Uvari, Tamil Nadu	5071	05/2013

15.	Study of shoreline changes using Remote Sensing Techniques for the development of Fish Landing Facilities at Uvari village near Kudankulam NPP, Tamil Nadu	5072	05/2013
16.	Mathematical model studies for shoreline changes for the development of Fish Landing Facilities at Uvari village, Tamil Nadu	5073	05/2013
17.	Design of breakwaters for the Development of Fish Boat Landing Facilities at Uvari village near Kudankulam NPP, Tamil Nadu	5074	05/2013
18.	Hydrodynamic studies to assess the impact of the proposed development of floating storage re-gasification unit at Kakinada deep water port	5075	05/2013
19.	Mathematical model studies for wave tranquility and shoreline changes for the development of Mini Fishing harbour at Varkala Chilakkoor, Kerala	5076	05/2013
20.	Flume studies for improving flow conditions near Bagmari Syphon across Farakka Feeder Canal, Farakka, West Bengal	5077	05/2013
21.	Hydraulic model studies for spillway of Punatsangchhu H.E. project Stage I, Bhutan	5078	05/2013
22.	Mathematical model studies for determination of safe grade elevation for survey 40 to 58 at Village Mharal, Ulhasnagar	5079	06/2013
23.	Physical hydraulic model studies for extension of guide bund and reclamation in Nhava creek at JNPT for M/s DP World on behalf of WAPCOS	5080	06/2013
24.	Area drainage studies for the proposed Thermal Power Project of TPCIL near Nellore, A.P.	5081	06/2013
25.	SECRET REPORT - Physical model studies for shifting the sand trap of south breakwater of Visakhapatnam Port	5082	06/2013
26.	Area drainage studies for proposed Solapur Thermal Power Project of M/s NTPC	5083	06/2013
27.	Vibration studies for Indira Sagar Power Station, Indira Sagar Project, NHDC Ltd., Khandwa, M.P.	5084	06/2013
28.	Hydraulic model studies for discharging capacity for full and partial gate operation of PARE dam spillway, Arunachal Pradesh	5085	06/2013
29.	Studies for design of storm water drains for Raghunathpur Thermal Power Station	5086	06/2013
30.	Field studies for rating of Tungabhadra Right Bank High Level Canal at Km 104-787, Bellary, Karnataka	5087	07/2013
31.	Interim Report on Monitoring of Blast Vibrations during capital dredging works for construction of second chemical liquid berth at	5088	07/2013

	Pir Pau, Mumbai Port		
32.	3D-Stress Analysis by finite element method of modified spillway Block No18 incorporating weak zones in foundation for Garudeshwar weir, SSNNL	5089	07/2013
33.	Desk and wave flume studies for the design of cross-sections for the offshore reefs for sustainable coastal protection at Ullal, Mangalore, Karnataka	5090	07/2013
34.	Estimation of site-specific seismic design parameters for Shivasamudram run-off river power project, Karnataka	5091	07/2013
35.	Hydraulic model studies for the proposed road bridge across river Yamuna downstream of Okhla barrage at New Delhi	5092	07/2013
36.	SECRET REPORT	5093	07/2013
37.	Performance test on 16MW turbine unit at Bhatghar Hydro Electric Power Station, Maharashtra State	5094	07/2013
38.	Water availability and intake studies for expansion of Rourkela Power Plant of NSPCL, Odisha	5095	08/2013
39.	Dam break and flood routing studies for Tilaiya UMPP, Jharkhand	5096	08/2013
40.	Central blast studies for excavation of rock for Yedgaon HE Project, Pune, Maharashtra	5097	08/2013
41.	Mathematical model studies to assess qualitative changes in river Vamsadhara near proposed Neradi Barrage	5098	08/2013
42.	Wave tranquility studies for development of fishing harbour at Poompuhar, Tamil Nadu	5099	08/2013
43.	Analysis and Interpretation of Dam Instrumentation Data, Omkareshwar Dam, M.P.	5100	09/2013
44.	Ship mooring analysis for the proposed Multi jetty at Cochin Port, Kerala	5101	09/2013
45.	Dam break studies for proposed reservoir of Visakhapatnam Steel Plant, Visakhapatnam	5102	09/2013
46.	Desk and wave flume studies for the design of Breakwaters for the development of fisheries harbour at Poompuhar, TamilNadu	5103	09/2013
47.	Mathematical model studies for flood drainage capacity of Additional Waterway Channel and Road Bridge No.1 on Mithi river within Chatrapati Shivaji International Airport (CSIA) area, Santacruz, Mumbai	5104	09/2013
48.	Mathematical model studies for the determination of safe grade elevation for proposed integrated power plant near Lara, Chattisgarh	5105	09/2013

49.	Area drainage studies for proposed integrated Thermal Power Project near Lara, Chattisgarh	5106	09/2013
50.	Desk & wave flume studies for the design of round heads of offshore breakwater for the development of outer to outer harbour at Visakhapatnam	5107	10/2013
51.	2-D Sectional model studies for the assessment of scour around bridge pier for proposed road bridge across river Yamuna downstream of Okhla barrage, New Delhi	5108	10/2013
52.	Electrical resistivity image study for detecting seepage at Talabira - 1 Coal Mine, Odisha	5109	10/2013
53.	Temperature control studies for Nilwande dam, Maharashtra	5110	10/2013
54.	Seismic profiling of intake channel of TAPS 3&4 Tarapur, Maharashtra	5111	10/2013
55.	SECRET REPORT - Storm surge analysis and storm wave hind casting for the proposed Nuclear Power Plant at Mithi Virdi, Gujarat	5112	11/2013
56.	Seismic study for the Kulu Multipurpose project for Brahmaputra Board, Assam	5113	11/2013
57.	Seismic study for the NOA-Dehing Multipurpose Project for Brahmaputra Board, Assam	5114	11/2013
58.	Seismic Tomography studies at Manikdoh dam, Kukadi Project, Maharashtra	5115	11/2013
59.	Mathematical model studies to simulate tidal hydrodynamics and sedimentation aspects for development of fisheries harbour at Mopla Bay, Kerala	5116	11/2013
60.	Mathematical model studies for protection measures for the wave disturbance inside the Jaigarh Port, Maharashtra	5117	11/2013
61.	Mathematical model studies for wave tranquility and shoreline changes for the development of fishing harbour at Poompuhar, Tamil Nadu	5118	11/2013
62.	Mathematical model studies for ship manoeuvring for the proposed development of outer harbour at Cochin Port, Kerala	5119	11/2013
63.	Mathematical model studies for tidal hydrodynamics and sedimentation for the development of Port facilities for M/s JSW at Tarapore, Thane, Mumbai	5120	11/2013
64.	Hydraulic model studies for desilting chambers for Mangdechhu HE Project, Bhutan	5121	12/2013
65.	Determination of rock properties and stability studies for rock slope and embankment at Talabira-1 Coal mine, Odisha	5122	12/2013

66.	Analysis and Interpretation of Dam Instrumentation Data for period Jan - 2012 to Dec 2012 for non overflow block 25, Indira Sagar Dam	5123	12/2013
67.	Area drainage studies for Kudgi Super Thermal Power Project of NTPC, Karnataka	5124	12/2013
68.	Determination of Geo-textile properties of Geobags Water Resources Dept., Siwan, Bihar	5125	12/2013
69.	Studies for determining in-situ properties of dam concrete, foundations materials and abutment rock of Bhakra dam at Nangal, Punjab	5126	12/2013
70	Mathematical model studies for wave tranquility and shoreline changes for development of mini fishing harbour at Poonthura, Kerala	5127	12/2013
71.	Development of Flood Forecasting model for Kol dam	5128	12/2013
72.	Estimation of Design wave conditions for proposed development of port facilities at Nandgaon, Thane	5129	12/2013
73.	Mathematical Model Studies for safe grade level determination of proposed integrated power plant near village Darlipali, Orissa	5130	12/2013
74.	MMS for determination of SGE for proposed power plant of RIL at Hazira, Gujarat	5131	01/2014
75.	Seismic refraction survey at Punatsangchhu -I Hydroelectric Project, Bhutan	5132	01/2014
76.	Ground penetrating radar (GPR) studies in the downstream portions of Kosi Barrage, Bihar	5133	01/2014
77.	Electrical resistivity survey at Punatsangchhu-I H.E. Project, Bhutan	5134	01/2014
78.	Desk studies for bank protection measures along the erosion prone reaches of nulla's in Diglipur, North Andaman	5135	01/2014
79.	2-D Sectional model studies for spillway of Ujh Barrage	5136	01/2014
80.	Storm surge analysis for proposed development of Port facilities at Nandgaon Dist. Thane	5137	01/2014
81.	Desk and wave flume studies for the design of training walls for the navigation channels at Thal, Raigad, Maharashtra	5138	01/2014
82.	SECRET REPORT - Hydraulogical studies for Saroda an Varsha rivers for project Varsha	5139	01/2014
83.	SECRET REPORT - 3D mathematical model studies for dispersion of warm water discharge from proposed Nuclear Power Plant at Jaitapur, Maharashtra	5140	01/2014

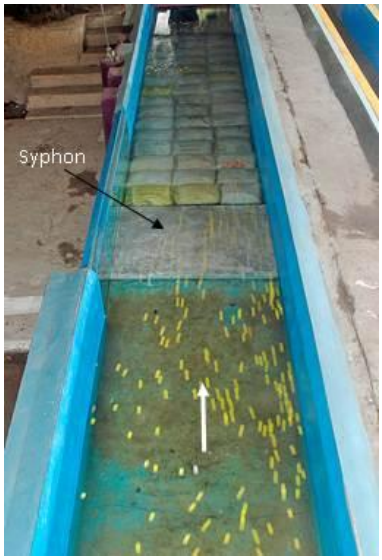
84.	Mathematical studies for wave transformation in the vicinity of Ennore port and Kattupalli port	5141	01/2014
85.	Mathematical model studies for intergrated morphological charges in the coastline between Ennore creed and L&T port including north of LLT port at Ennore, Tamil Nadu	5142	01/2014
86.	Wave flume studies for the design of the breakwaters for the proposed development of outer harbour at Cochin Port	5143	01/2014
87.	Wave flume studies for strengthening of the existing sea-wall for sea shore temple at Mamallapuram, Tamil Nadu	5144	01/2014
88.	Hydraulic model studies for revised design of Punatsangchhu-I dam spillway, Bhutan, 1:50 scale 2-D sectional model	5145	01/2014
89.	Hydraulic model studies for Mangdechu Dam Spillway, Bhutan 1:40 scale 2-D Sectional Model	5146	02/2014
90.	Ship mooring analysis for revised alignment of MULT jetty at Cochin Port, Kerala	5147	02/2014
91.	Head loss test / fuel measurement in water conductor system Baira Siul Power Station	5148	02/2014
92.	Analysis and Interpretation of dam instrumentation data for period January 2012 to December 2012 for new overflow block 13, Indira sagar Dam, M.P.	5149	02/2014
93.	Physical hydraulic model studies for the new proposal of development of fourth container terminal at JNPT	5150	02/2014
94.	Hydraulic performance and overload tests on submersible pumpsets of various capacity and head for UPID 2013	5151	02/2014
95.	Trends in water quality of Khadakwasla reservoir	5152	02/2014
96.	Mathematical model studies for reservoir sedimentation for Arun III H.E. Project, Nepal	5153	02/2014
97.	Mathematical model studies for flood protection measures of Gareli Khad, Himachal Pradesh	5154	02/2014
98.	Hydraulic performance and overload tests on submersible pump set of 102m3/hr capacity and 36m head for M/s Rockwell Pumps and meters Pvt. Ltd., Ghaziabad (UP)	5155	03/2014
99.	Design of breakwaters for the development of fishery harbour at Thanur in Malappuram, Kerala	5156	03/2014
100.	Physical model studies for establishing a ship repair facility in Mattancherry channel at Cochin Port, Cochin	5157	03/2014
101.	Studies for design of training wall/groune for the development of fish	5158	03/2014

	landing centre at Belekeri in Uttar Kannada (Dt.), Karnataka		
102.	Hydraulic physical model studies for Flotrilla Berths at New Mangalore Port	5159	03/2014
103.	Desk and wave flume studies for the design of groynes for the navigational channel at Theronda, Raigad, Maharashtra	5160	03/2014
104.	Mathematical model studies for flood protection works from Palchan to Larja on river Beas, H.P	5161	03/2014
105.	Study on diversin of Kewari Nala Passing through the Jitpur coal block at Godda, Jharkhand of M/s Jindal Power Ltd.	5162	03/2014
106.	Pressure drop test on filters of M/s Filtration Engineers India Pvt. Ltd., Mumbai	5163	03/2014
107.	Mathematical model studies for littoral drift, shoreline evolution and mitigation measures for petronet LNG terminal at Kochi, Cochin Port Trust, Kerala	5164	03/2014
108.	Hydraulic model studies for proposed Mumbai Trans harbour Link (MTHL) at Mumbai	5165	03/2014
109.	Design of breakwaters for the development of fishery harbour at Vellayil in Kozhikode, Kerala	5166	03/2014
110.	Mathematical model studies for the development of coal berth facility at Dahej (Hazira) in Gujarat state for M/s Reliance Industries Ltd.	5167	03/2014
111.	Mathematical model studies for the development of coal berth facility at Hazira in Gujarat state for M/s Reliance Industries Ltd.	5168	03/2014
112.	Wave tranquility studies for development all weather captive port facility at village Nandgaon, Palghar taluka, Thane	5169	03/2014

RIVER ENGINERING

5077-FLUME STUDIES FOR IMPROVING FLOW CONDITIONS NEAR BAGMARI SYPHON ACROSS FARAKKA FEEDER CANAL, FARAKKA, WEST BENGAL

Bagmari Syphon is one of the structures constructed across the Farakka Feeder Canal at RD 48 i.e. 14.6 km from canal head regulator to cross the river Bagmari. It was observed that a deep scour pocket had developed at downstream of the Bagmari syphon. During site inspection, it was noticed that the original 1.219 m thick layer of compacted soil over the top of syphon (RL 13.715 m) had also been eroded in the course of time. Farakka Barrage Authorities (FBA) had provided 0.911 m thick layer of boulders over the syphon as a counter weight for safety of syphon against uplift. However, these boulders had unevenly settled over the syphon causing fluming of the flow resulting in difficulty to the movement of vessels belonging to Inland Waterways Authority of India (IWAI) passing through the feeder canal over the syphon. The problem was getting accentuated during the low flows in the canal. The matter was discussed in the Canal Study Group meeting of FBA and was referred to CWPRS for assessing the cause for the difficulty in movement of vessels. Initial 1-D Mathematical model studies indicated that due to the uneven laying of stones, the flow gets concentrated to small widths (fluming) whereby the velocities increase and depth of flow decreased. The flumed portion of the syphon experienced a maximum velocity of 2.29 m/s and the minimum flow depth was 1.52 m for a discharge of 453 m^3/s under existing conditions. The velocity decreased to 1.32 m/s and flow depth increased to 2.14 m for the same discharge when the boulders over and above RL 14.5 m were removed and levelled. However, the effect of scour holes on upstream and downstream of syphon could not be studied on the 1 D mathematical model. At the request of Technical Advisory Committee (TAC) of FBP a 2 D sectional flume model (G.S. 1:40) studies were carried out for improving flow conditions near Bagmari syphon. The studies indicated similar results as indicated by the 1 D mathematical model in respect of velocity, depth of flow and uniform flow conditions over the syphon. The scour filling up to RL 13 m immediately downstream of syphon to RL 5.13 m (existing bed level) at RD 49.1 on downstream and RL 13 m immediately upstream of syphon to RL 4.64 m (existing bed level) at RD 47.5 on upstream, improved the flow conditions by suppressing the secondary flow currents arising out of decelerating flow due to expansion and hence recommended. It was recommended to provide armour (possibly stone filled crates) in two layers, in case, if the filling of the scour pockets was proposed to be done using erodible materials like sand filled HDPE bags. This would reduce the recurrence of scour.



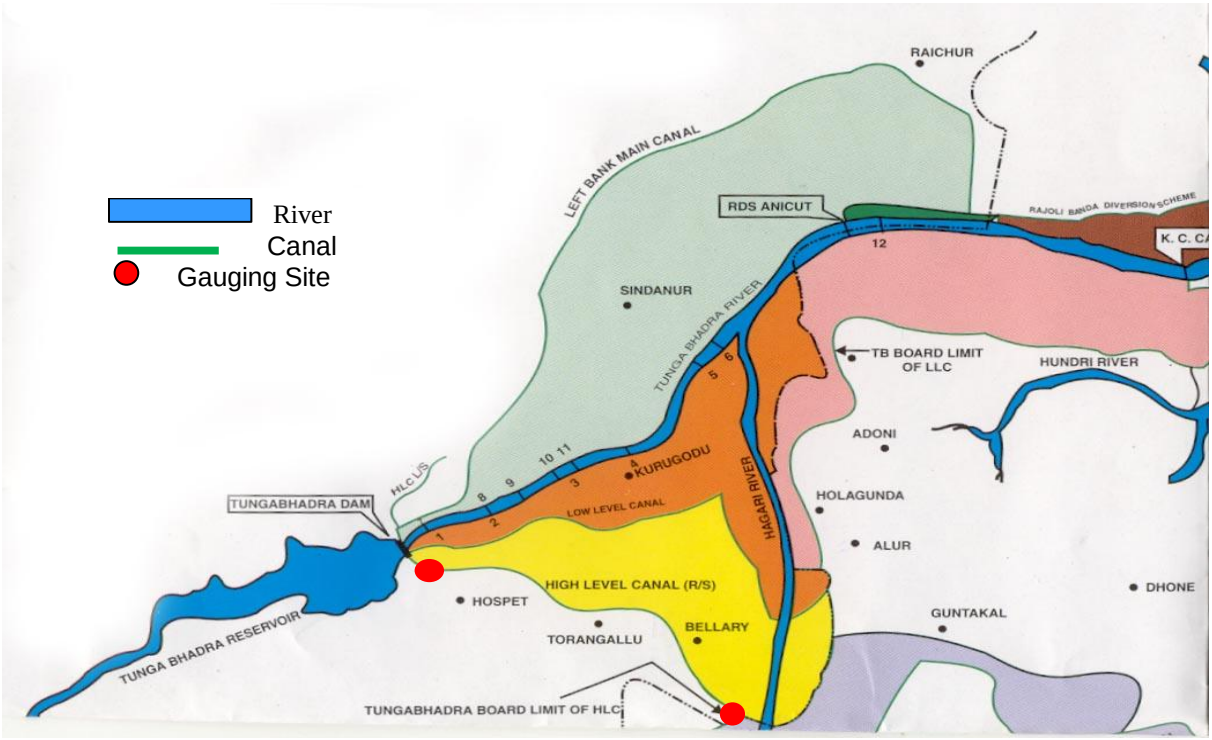
5087-FIELD STUDIES FOR RATING OF TUNGABHADRA RIGHT BANK HIGH LEVEL CANAL AT KM 104.787, BELLARY, KARNATAKA

Tungabhadra Dam was constructed across Tungabhadra River near Hospet in Bellary district of Karnataka state. It is a multi-purpose and interstate project between Karnataka and Andhra Pradesh. High Level Canal (HLC), Power canal and Low Level Canal (LLC) take-off from Tungabhadra dam along the right bank. The water from Tungabhadra dam, released into right bank canal is utilised for providing irrigation to agricultural lands in above states and for power generation. The Tungbhadra Board requested Central Water and Power Research Station, Pune to undertake field studies for rating of HLC at Km 104.787. The field studies were undertaken in August 2010, January 2011 and February 2012 for different discharges varying from 31.66 m^3/s to 60.47 m^3/s under the stable flow conditions in the canal. The discharge in the canal was measured using Area Velocity method. The depth measurements were taken by Echo sounder and the velocity observations were carried out by using self recording propeller type currentmeter manufactured by Valeport Ltd. U.K. The Gauge-Discharge relationship, evolved from the statistical analysis of observed data was as under :

$Q = 5.01 \times G^{2.09}$

Where Q = Discharge in m^3/s

G = Gauge / Flow depth in metre

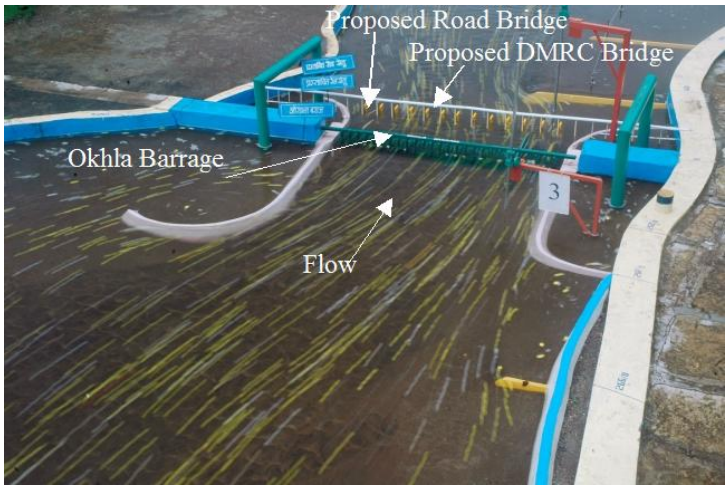


Tungabhadra canal system

5092-HYDRAULIC MODEL STUDIES FOR THE PROPOSED ROAD BRIDGE ACROSS RIVER YAMUNA DOWNSTREAM OF OKHLA BARRAGE AT NEW DELHI

The Yamuna river flows in the north-south direction by the side of eastern border of Delhi for a length of about 50 km from Palla to Jaitpur. The width of the river in the region varies between 1.0 km and 4.5 km. Thirteen hydraulic structures already exist on river Yamuna in the urban area of Delhi from Wazirabad barrage to Okhla barrage. New Okhla Industrial Development Authority (NOIDA) had proposed to construct a road bridge across river Yamuna at Delhi, downstream of Okhla barrage. CWPRS was approached with a request to examine the technical feasibility of the proposal through hydraulic model studies. The studies were carried out on the existing mobile bed model of river Yamuna at Delhi, constructed to a horizontal scale of 1:300 and a vertical scale of 1:60 covering the river reach of 50 Km from Palla to Jaitpur. The model bed from Wazirabad barrage to 5 km downstream of Okhla barrage was updated and moulded as per post flood survey of 2007. The model studies were carried out for the proposed bridge at four different locations 1) 57.5 m downstream of Okhla barrage 2) 185 m downstream of Okhla barrage 3) 50 m downstream of Okhla barrage 4) 120 m downstream of Okhla barrage.

Studies were carried out with river discharges of 7,022 m^3/s, 9,910 m^3/s and 12,750 m^3/s with and without the proposed bridge. These Studies indicated that the proposed bridge approximately 120 m downstream of Okhla barrage (i.e. 35 m downstream of proposed DMRC bridge) with 574 m waterway would be hydraulically suitable. The maximum water level of 204.55 m was observed at proposed bridge for the discharge of 12750 m^3/s. An afflux of 28 cm was observed at the proposed bridge 120 m downstream of Okhla barrage for the discharge of 12750 m^3/s. Both the guide bunds of Okhla barrage are required to be extended approximately 270 m downstream to improve the flow conditions at the proposed bridge site. Measurement of water level, velocity and discharge intensities along the proposed bridge indicated no undesirable flow conditions at the existing Okhla barrage. Protection works in the form of stones in crates of suitable size were also suggested. The location of the proposed bridge approximately 120 m downstream of Okhla barrage (i.e. 35 m downstream of proposed DMRC bridge) was hydraulically found satisfactory.



Flow pattern in the vicinity of proposed Road bridge 35 m downstream of DMRC bridge across river Yamuna at Delhi

5098 -MATHEMATICAL MODEL STUDIES TO ASSESS QUALITATIVE CHANGES IN RIVER VAMSADHARA NEAR PROPOSED NERADI BARRAGE

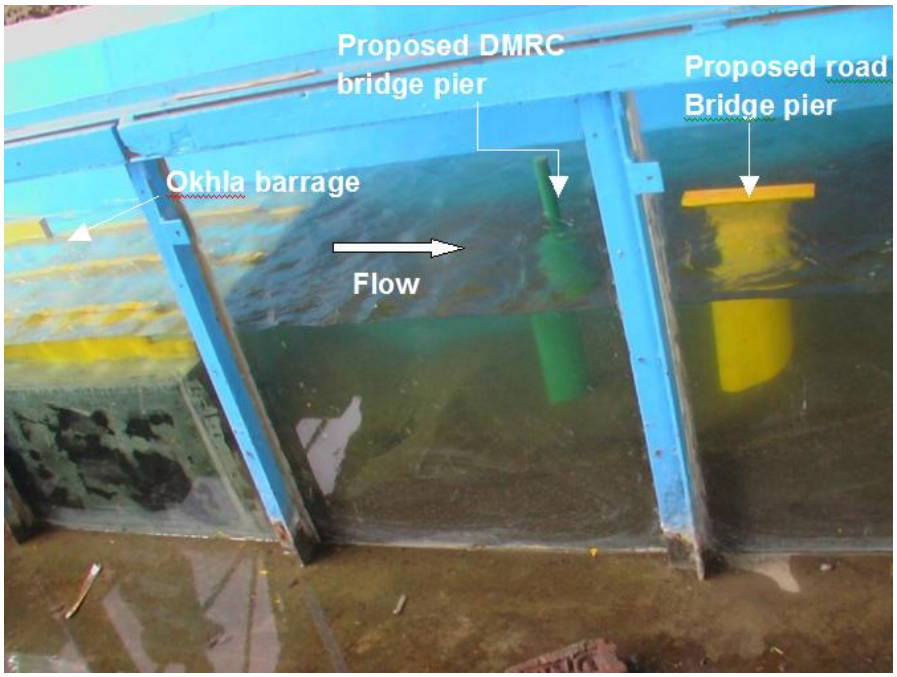
A Barrage was proposed to be constructed across river vamsadhara at Neradi village of Srikakulam District, Andhra Pradesh to cater for the irrigation. The Government of Andhra Pradesh referred physical model studies to CWPRS in the year 2002 for determining the extent of back water and in 2006 for the proposed side weir near Katragada, which is at about 2 km upsream of proposed Neradi barrage. CWPRS had conducted these studies and the findings of the studies were submitted vide Technical Report No. 4212 of February 2005 and Technical Report No. 4459 of July 2007. The matter of implementation of the above project was opposed by Govt. Of Odisha on few issues. The matter was under the consideration of Vamsadhara Water Dispute Tribunal (VWDT), New Delhi for arbitration. VWDT during its visit to CWPRS on 3.5.2013, had directed both the states to conduct fresh survey of river Vamsadhara jointly and to submit the data to CWPRS for comparing it with old data and also to decide the necessity of conducting fresh model studies. Accordingly, joint survey was conducted by both the states and data was submitted to CWPRS for verification on 5th July 2013. However, the alignment of newly surveyed data and zero of the cross section was different from the old data and they were incomparable. Therefore, as per the direction of VWDT, a meeting attended by concerned engineers was held on 5-6 August 2013 at CWPRS, Pune to reconcile the submitted data. During the meeting, it was unanimously agreed that reconciliation of data was not possible by either state representatives or CWPRS. Hence, CWPRS opined to conduct mathematical model studies with the newly surveyed data for assessing the extent of backwater and the result may be compared with the past model study results to get an idea about the changes if any. Agreeing to the above opinion, VWDT desired that CWPRS may take the needful action in the matter.

The studies conducted on one dimensional mathematical model HEC-RAS revealed that the extent of back water length after construction of Neradi barrage would be of the order of 6 km upstream of barrage for a discharge of 16,990 m^3/s, which was same as the results obtained from the earlier physical model studies. For a discharge of 16,990 m^3/s, increase in water level at cross section No. 2 (2 km upstream of barrage) over the existing condition (pre-barrage condition) was 5 cm., whereas it was 72 cm with the studies conducted during 2005. The rise in water level for a discharge of 16,990 m^3/s at cross section No.6 was of the order of 1 cm and it was 16 cm with the physical model study conducted earlier (2005). In both the cases, the rise in water level was nil at cross section No.7 upstream of proposed barrage. In view of these results, it was decided that there was no major change in the river.

5108-2D SECTIONAL MODEL STUDIES FOR THE ASSESSMENT OF SCOUR AROUND BRIDGE PIER FOR PROPOSED ROAD BRIDGE ACROSS RIVER YAMUNA DOWNSTREAM OF OKHLA BARRAGE, NEW DELHI

New Okhla Industrial Development Authority (NOIDA) had proposed a road bridge across River Yamuna downstream of Okhla barrage. The proposed bridge was having a waterway of 574.0 m with 14 spans of 41.0 m center to center with elongated piers of varying thickness built on a double-D type foundation. The proposed bridge was downstream of Okhla barrage at a distance of about 120 m (i.e. 35 m downstream of proposed DMRC bridge). The barrage discharges sediment free water during major part of the year due to ponding of water. This could induce degradation of the river bed downstream of the barrage. In view of this complexity, it was decided to study the scour around bridge pier on a 2-D flume model. The maximum discharge intensity observed on the composite model of river Yamuna corresponding to check flood discharge of 12,750 m^3/s was 40.0 $m^3/s/m$. The corresponding maximum water level was RL 204.55 m. This data was considered while conducting studies in the flume model for assessing scour around the proposed road bridge piers.

The studies were conducted on a 1:80 scale geometrically similar 2-D sectional mobile bed model built in a flume of 0.9 m wide and 20 m length. The pier was reproduced at the center of the flume with little more than half span widths on either side of the pier. The silt of size D50 = 0.2 mm was used on the model for studies. It was selected based on the necessary condition that the shear stress exerted by the given flow in the model exceed the critical shear stress computed according to the shields parameter. The deepest scour depth was measured after passing the discharge until the equilibrium condition was attained in the model (stabilized bed condition). The model studies indicated the maximum depth of scour to be about 37.0 m below HFL and the corresponding deepest scour level was assessed as RL 167.55 m.



Model studies with the discharge intensity of 40.0 $m^3/s/m$ corresponding check flood discharge of 12,750 m^3/s

5135-DESK STUDIES FOR BANK PROTECTION MEASURES ALONG THE EROSION PRONE REACHES OF NULLAH'S IN DIGLIPUR, NORTH ANDAMAN

The agricultural lands on the banks of the Kalpong river and nullah's near Diglipur were eroded during the floods of year 2010. Concerned over the erosions, APWD, Diglipur, North Andaman, referred the problem to CWPRS Pune to suggest necessary bank protection works. Officials from CWPRS, Pune conducted joint site inspection of erosion reaches of nullah's in Diglipur with officials from APWD, Diglipur, North Andaman on 26th February 2011. Based on the site inspection and discussions, a report was submitted to the project authorities including the proposal for further study after receipt of data which was enclosed in the said report. Based on the receipt of data from APWD, Diglipur, the comprehensive study for bank protection measures were carried out.

Study with the help of one dimensional mathematical model (HEC-RAS) was carried out to assess the hydraulic parameters for designing the bank protection works. Maximum velocity of 4.3 m/s in Kalpong river and 3.8 m/s in Krishnopuri nullah without tides and 4.35 m/s in Kalpong river and 4 m/s with tides was computed by one dimensional mathematical model. Based on the maximum velocity, Stones in crates of size 1 m x 1 m x 0.9 m in Kalpong river and 1 m x 1 mx 0.5 m in Krishnopuri nullah along sloping bank of 2.5 H: 1V (not less than 2 H: 1 V) laid over the properly dressed bank and over the geofabric filter sandwiched between 15 cm thick layers of sand above the toe wall was recommended. The launching apron of desired width was also recommended. In the areas where land constraints exist, other methods such as gabion gravity wall/retaining wall, gabion studs/spurs along with the launching apron, and series of RCC porcupines as per the site conditions in Krishnopuri nullah were suggested. To restrict the tides in to the river, construction of a tidal regulator was also suggested.

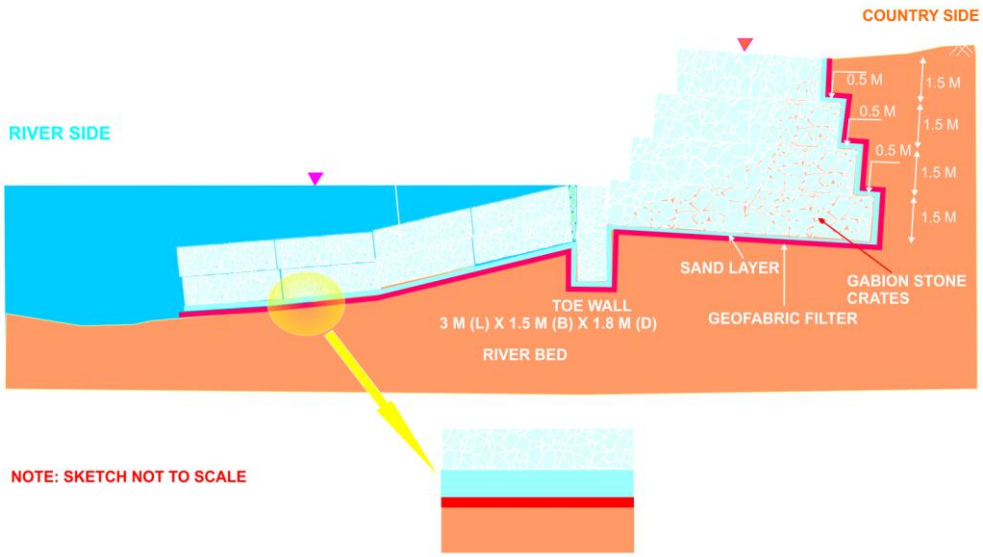
5154-MATHEMATICAL MODEL STUDIES FOR FLOOD PROTECTION MEASURES OF GARELI KHAD, HIMACHAL PRADESH

The Gareli khad, a major tributary of Jabbar khad in Kangra District of Himachal Pradesh experiences typical flashy floods during monsoon. The Gareli khad was fed by a number of streams carrying large quantity of sediment load which gets deposited resulting in aggradation of river bed. Gareli khad creates havoc during monsoon almost every year due to the floods. During the floods valuable agricultural land was either washed away or rendered unproductive due to sediment deposition over the fertile land. Hence, studies for flood protection works were carried out by CWPRS for deciding alignment and design of bank protection works. Since there were no existing rain gauge or river gauging stations in the catchment area of Gareli khad, design flood was estimated from rainfall-runoff data of hydro-meteorologically homogeneous catchments and Synthetic Unit Hydrograph (SUH) Technique as per the guidelines of CWC. Physiographic Parameters of the catchment of Gareli Khad were derived using GIS Techniques. The SRTM DEM was processed using HEC-GeoHMS and ARC GIS software. HECRAS software was used to estimate the water surface profiles and other hydraulic parameters for the design of river protection measures. The levees were proposed on both banks with a side slope of 2H:1V. The river side of the levee should be protected with one layer of stone in crates of size 1.0 x 1.0 x 0.5 m laid above a geo-synthetic filter. To protect toe of the embankment, launching apron is suggested. The launching apron would consist of two layers of stones in crates of size 1.0 m x 1.0 m x 0.5 m laid over geo-synthetic filter. A 150 mm thick layer of coarse sand should be laid over geo-synthetic filter to avoid fabric rupture during placement of stones.

5161-MATHEMATICAL MODEL STUDIES FOR FLOOD PROTECTION WORKS FROM PALCHAN TO LARJI ON RIVER BEAS, HIMACHAL PRADESH

River Beas originates at Beas Kund in the Pir Panjal range of the Himalayas at an elevation of 4085 m. Frequent cloud bursts and flashy floods in the area had caused erosion of banks and loss to the valuable properties, agricultural land Orchard fields, etc. located adjacent to the banks of the river Beas. Concerned over the frequent erosion, Irrigation and Public Health (I&PH) Department of Himachal Pradesh, requested Central Water and Power Research Station (CWPRS), Pune to conduct mathematical model studies for suggesting flood protection works on river Beas from the reach Palchan to Larji. Flood of 2355 m^3/s at Larji has been worked out for 25 year return period based on the statistical analysis of discharge data. One-dimensional mathematical model (HECRAS) was used to extract hydraulic parameters for deciding suitable bank protection work in the form of Crates in dressed sloping bank and embankments were recommended for flood protection.

The Gabion walls ranging from height 3 m to 6 m were also suggested at places where the bank slopes were steep and space restrictions were encountered. Toe wall and launching apron of suitable sizes for different river reaches along with geo-fabric filter was recommended. Other suggestions included removal of large sized boulders from the centre of river and using the same for bank protection works, splitting of large boulders to avoid easy rolling, restoration and maintenance of existing protection works, river front development in the selected reaches without disturbing the river regime for tourism development, etc.



Gabion wall protection for 6 m height bank

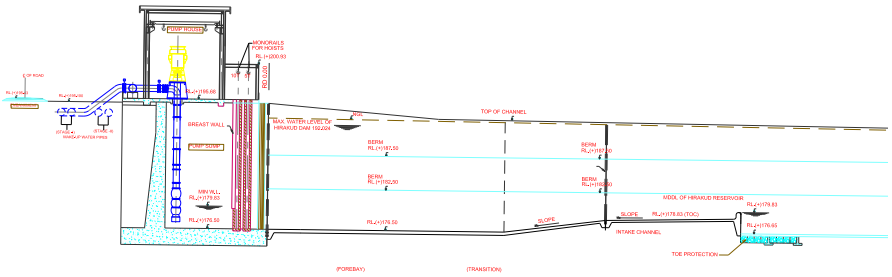
RIVER & RESERVOIR SYSTEMS MODELLING

5068-STUDIES FOR LOCATION AND TYPE OF INTAKE FOR PROPOSED DARLIPALI SUPER THERMAL POWER PROJECT, DIST. SUNDERGARH, ORISSA

M/s. NTPC had proposed to set up a power plant with installed capacity of 3200 MW in two stages of 2 x 800 MW each. The site is located near village Darlipali in Sundergarh District of Orissa State. Studies were referred to CWPRS for deciding the location and type of intake for proposed STPP for water requirement of 3.13 m^3/s. The topographic and hydrographic data for alternative intake location were used in the present studies. The studies were carried out in three stages. Initially inspection of the site was carried out to get the acquaintance with site conditions and to select possible alternative locations for intake. The reconnaissance indicated that the alternatives at location near Lapanga, Patrapali, Barredungri (Bhobra/Dungari) could not be considered appropriate due to inadequate depths during fair weather season.

The hydrographic survey was analyzed for alternative sites for intake in Ib arm of Hirakud reservoir due to proximity to the proposed plant site. The data indicated that available depths were only 2 to 3 m and after check measurements, these locations were rejected. Further investigations were carried out for identifying the possible locations in Mahanadi arm of Hirakud reservoir. Accordingly, check measurements of depths were taken and alternative locations were identified near $83^0 52' 9.9''$E and $21^0 38' 32.7''$N for locating the intake. A team of NTPC officers visited the water spread area of Hirakud reservoir to review the situation around the intake location proposed by CWPRS. The observations of the team were communicated and also requested to comment on additional area of hydrographic survey for locating intake i.e. pump house at the bank with channel extending upto the minimum drawdown level of the reservoir. In reply, CWPRS observations were also submitted and proposed a joint meeting also with NTPC. Accordingly, a joint meeting was held and detailed discussions were held on the pros and cons of location and type of intake structure, NTPC officials explained issues associated with construction of intake well i.e. placing, sinking, toeing etc. in the existing reservoir. Finally, it was decided jointly that possibility of pump house at the bank with channel extending into the reservoir is to be explored through additional hydrographic survey. In this connection, NTPC had made available the additional survey data to CWPRS. Based on the survey data, site inspections and discussions, the approach channel was located on longitudinal section 9 (O-OI) based on the minimum cutting/dredging of bed of the reservoir and a schematic diagram of gravity type intake was prepared.

It was suggested to take necessary measures to ensure that the approach channel reaching the sump should be free from sediment throughout the life of plant. Necessary bank protection measures were suggested in the vicinity of the intake location. It was also suggested to provide toe wall and apron in the vicinity of the intake location.



Schematic diagram of gravity type intake structure

5079-MATHEMATICAL MODEL STUDIES for DETERMINATION OF SAFE GRADE ELEVATION FOR SURVEY NO. 40 TO 58 AT VILLAGE MHARAL, ULHASNAGAR

M/s Regency Nirman Limited, Mumbai, was developing their land located at survey no. 40 to 58 at village Mharal, Ulhasnagar, Maharashtra for residential cum commercial purpose. The project site was very close to Ulhas river, a major west flowing river in Maharashtra. Ulhas river and its surrounding areas experienced extreme flood event on 26th July 2005 during which the proposed site was submerged. M/s Regency Nirman Ltd. through WAPCOS requested CWPRS Pune to carry out Mathematical model study for determination of Safe Grade Elevation and suitable Area Drainage Study for project site. Discussions were held with officers of M/s WAPCOS, Pune and M/s Regency Nirman Ltd., Mumbai and the scope of work was finalized. A site visit was carried out along with officers of WAPCOS, Pune on 25.10.12 to get acquaintance with the project site. The Ulhas river reach of 15 km from Jambhul weir to Mohne weir was simulated for the mathematical model study. The topography of Ulhas river reach under consideration was simulated using river cross section data available at CWPRS and the data supplied by WAPCOS. The peak flood discharge of different return periods were estimated using rational formula taking into consideration of various parameters such as catchment area, catchment characteristics & estimated rainfall intensities for 25, 50,100 year return period and PMP. Intensity of rainfall varies between 34.62 mm/hr to 76.79 mm/hr for different return period rainfalls, which generates a peak discharge ranging between 6360 m^3/s to 14110 m^3/s. However the observed discharge during last 25 years was about 4440 m^3/s only.

Mathematical model was adequately calibrated for the flood on 26th July 2005. The predicted flood level in Ulhas river were in good agreement with the observed flood level near Mohne weir as well as other location on upstream. The mathematical model results indicated that at the chainage 0.60 km upstream of Mohne Weir (North West- Corner of project site) the water levels are computed to be in the range of 12.75 m to 15.66 m for different return period floods. While at chainage 1.05 km upstream of Mohne weir (North East- Corner of project site) this range varies from 13.04m to 15.90 m. therefore the floor for all residential buildings was kept at 16.80 m and Safe Grade Elevation for commercial complexes was determined as 14.50 m. For safe passage of storm water from upper catchments of project, resection of existing nallas have been suggested. It is suggested to provide a rectangular concrete duct below the developed site, in place of existing eastern nalla keeping the entry and exit points of the nalla to the project site as undisturbed. Suitable storm water drainage system was also designed for safe evacuation of flood water from the site. The model runs were also taken for predicting flood levels under post project conditions. The study of water surface profile for post project scenario shows very marginal increase in water level in the upstream reach.

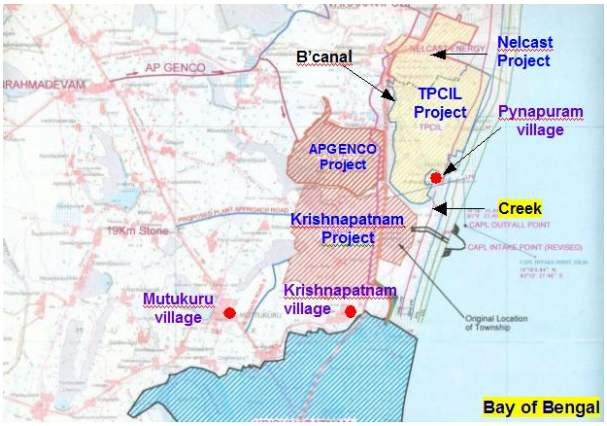
View of site of M/s Regency Nirman Ltd. near Ulhas river

5081-AREA DRAINAGE STUDIES FOR PROPOSED THERMAL POWER PROJECT OF M/S TPCIL NEAR NELLORE, ANDHRA PRADESH

M/s Thermal Powertech Corporation of India Limited (TPCIL), Andhra Pradesh (AP) had proposed to construct a coal based Thermal Power Project (TPP) with an installed capacity of 1320 MW (2 x 660 MW) in Nellore District, AP. Area drainage studies and determination of Safe Grade Elevation (SGE) for the TPCIL project were carried out on request of M/s WAPCOS. The project is spread on an area of 6.28 km^2. The project site is bound by sea coast of Bay of Bengal, Pynapuram creek, Buckingham Canal (B'canal) and Nelcast TPP as shown in Figure. The area receives rainfall from southwest and northeast monsoons, as well as from cyclonic storms over the Bay of Bengal. The rainfall data (daily and hourly) from India Meteorological Department (IMD) were made available by WAPCOS. The Extreme Value Analysis (EVA) of the daily and hourly rainfall data was carried out using EV-I distribution and 1-day and sub-daily maximum rainfall with 50-yr and 100-yr return periods was estimated.

WAPCOS provided survey data of project area and cross sections of creek and Buckingham canal (B'canal) as well as tidal water level data in creek and B'canal. The project was free from external flooding as no external stream pass through or along its boundary and flood inundation in the project area was only due to storm water from rainfall. The tide levels in the adjoining creek play an important role in clearing storm water from project area. Based on these, flood inundation levels in plant area were estimated by developing Digital Elevation Model (DEM) of the area and superimposing flood volume over it resulting from an extreme (100-yr) storm of 3-hr and 6-hr. The inundation level in the plant area was estimated as 1.74 m and 1.86 m for 3-hr and 6-hr extreme storm rainfall respectively.

Using the inundation levels estimated and also considering high tide levels in creek and B'canal, storm surge level and topography of the area, the SGE for the plant area of TPP was determined as RL 4.50 m above MSL. Subsequently, technical discussions with project officials and WAPCOS on different aspects resulted in obtaining an optimized SGE of plant area as RL 4.30 m above MSL. Using the general layout plan of plant area provided by TPCIL and the invert levels at outfalls of Storm Water Drainage (SWD), SWD network was designed for plant area. After discussions with project authorities and WAPCOS, it was mutually agreed that outfall of the drains would be fixed at level of RL 2.2 m at project boundary for drains discharging to inland channels and RL 2.7 m where SWD directly discharges in to sea.



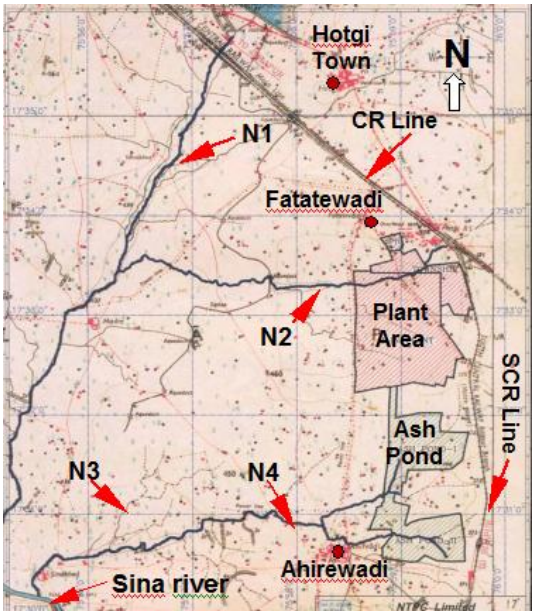
Vicinity map of TPP of TPCIL near Nellore, AP

5083-AREA DRAINAGE STUDIES FOR SOLAPUR THERMAL POWER PROJECT OF NTPC, MAHARASTHRA

NTPC Limited has proposed to set up a coal based Thermal Power Project (TPP) with an installed capacity of 1320 MW (2 x 660 MW) near Solapur, Maharashtra. Area drainage studies and determination of Safe Grade Elevation (SGE) for the TPP were carried out on the request of NTPC. The proposed project site was about 14 km from Solapur and near Hotgi town. The site was bound by village Fatatewadi, Hotgi and South Central Railway (SCR) line on north; Solpaur-Bijapur Railway line of SCR on east; Fatatewadi-Ahirewadi road on west and; Ahirewadi village and agricultural farms on south. The area was more or less a flat land with little undulations. The plant location was on the elevated portion of project area.

The available rainfall data (daily and sub-daily) were procured by CWPRS from India Meteorological Department (IMD). The Extreme Value Analysis (EVA) of the daily and hourly rainfall data was carried out using EV-I distribution and 1-day and sub-daily maximum rainfall with 50-yr and 100-yr return periods was estimated.

Data on daily gauge and discharge (G-D) observed by Government of Maharashtra at Bandalagi G-D site on Sina river was also procured by CWPRS. Catchments influencing the project area were delineated and unit hydrographs (UH) were developed for sub-catchments. Using the UH and extreme rainfall for 100-year return period, extreme flood from each sub-catchment was estimated. NTPC provided survey data on spot elevations in project area and cross sections (CS) of streams and Sina river. Gauge and discharge data of G-D sites on Sina and Bhima rivers were obtained from WRD, Government of Maharashtra. Using the CS data of streams and adopting 1-D flood routing model HEC-RAS the extreme flood was routed through the stream network to estimate Highest Water Level (HWL) at different locations of interest in the project area. Using the HWL estimated and the length and slope of storm water drain from project area the Safe Grade Elevation (SGE) was determined.



Vicinity map of Solapur TPP

5086-STUDIES FOR DESIGN OF STORM WATER DRAINS FOR RAGHUNATHPUR THERMAL POWER STATION

The Damodar Valley Corporation (DVC) had proposed to generate 800 MW thermal power by building and operating Raghunathpur Thermal Power Station (RTPS) near village Raghunatpur in Purulia District of West Bengal. In this regard, WAPCOS approached CWPRS to conduct studies on area drainage and determination of Safe Grade Elevation for the Raghunathpur TPS. The studies were completed and final technical report (TR No.4688) was submitted to WAPCOS in January 2010. Subsequently, WAPCOS requested CWPRS in November 2011 and September 2012 to visit the RTPS site as the project has re-oriented the drains and have inundation problems. Accordingly, the present studies were taken up and site inspection was conducted to comprehend the existing site conditions and the inundation issues. It was observed that the project authorities have plans of four storm drain (M1, M2, M3 and M4) outlets from RTPS area and intend to drain an outside nalla on the west side through the project area and outfall the storm water through M1.

Desk studies were carried out to re-design the storm drains and also diversion of some outside drains at northeast, northwest and west sides of project area and drain them through the project area with outfall at the north i.e. drain M1. Downstream of M1 outfall dredging of nala upto a distance of 1.0 km to maintain the slope has been suggested. Further, the drains M2, M3 and M4 were also re-designed as there were changes in the contributing areas to these drains. M4 drain is independent drain bringing storm water from west part of plant i,e. Coal handling and lay down areas and outfall near the main entrance of the RTPS project. To aid the proper drainage at the outlets of these drains near project boundary size of box culverts were also suggested.

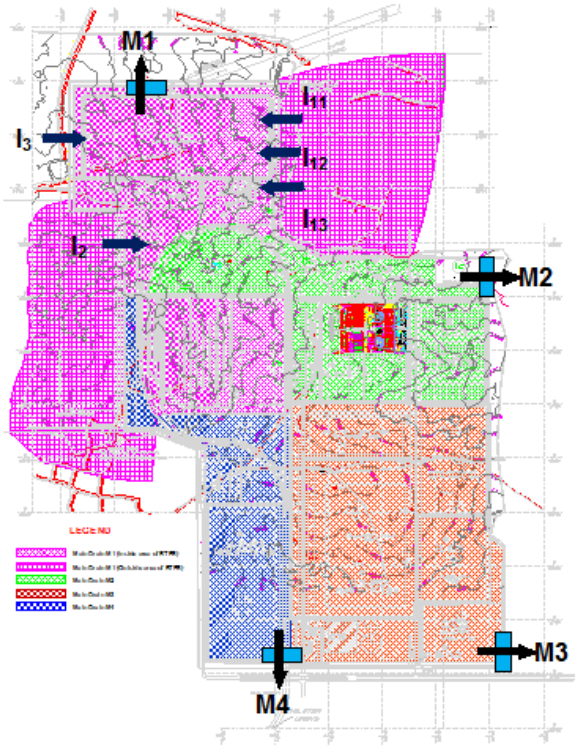


Figure shows partitioning of project area based on contributing area of drains

5095-WATER AVAILABILITY AND INTAKE STUDIES FOR EXPANSION OF ROURKELA POWER PLANT OF NSPCL, ODISHA

The NSPCL, a joint venture of NTPC and SAIL had proposed expansion of Rourkela Power Plant by one unit of 250MW in Odisha. It was proposed by project authority to draw additional requirement of 0.425 m^3/s raw water by locating an Intake in Brahmani river about 100 to 150 m upstream of existing Intakes of RSP near Tarkera weir. NSPCL requested CWPRS to carryout Water availability and intake studies to suggest suitable location and hydraulic design for its Intake well.

Topo-sheet of 1970, Satellite imageries for the year 1989, 2000 and 2012 were analysed to decide suitable Intake location, which was confirmed by the river cross-section data. Hence proposed location of intake well about 70 m upstream of existing RSP intake and at 80m from left bank in the deep channel of Brahmni river was found hydraulically feasible. The G-Q data at Panposh gauging site was used to validate the results of one-dimensional mathematical model HEC-RAS with discharges at the upstream boundary and normal depth at downstream boundary. The maximum discharge intensity corresponding to design flood was about 48.84 $m^3/s/m$, which along with d_{50} value of bed material (0.31 mm) was used to decide the maximum scour level as RL 170.96 m considering the HFL at RL 207.0 m. It was, therefore, recommended to provide the foundation level by considering sufficient grip length below the maximum scour level of 170.96 m. To draw required quantity of water, one opening of size 2.2 m x 1.0 m in the intake was recommended at each of two different levels considering the standard drawal velocity of 0.2 m/s. It was suggested to operate the gates effectively during monsoon so as to minimize sediment entry and provide adequate capacity slurry pumps for removal of accumulated sediment. Bank protection works in the form of stones in crates over a synthetic filter were suggested from 100m upstream to 50m downstream of proposed intake location.

Proposed Intake upstream of existing RSP Intake

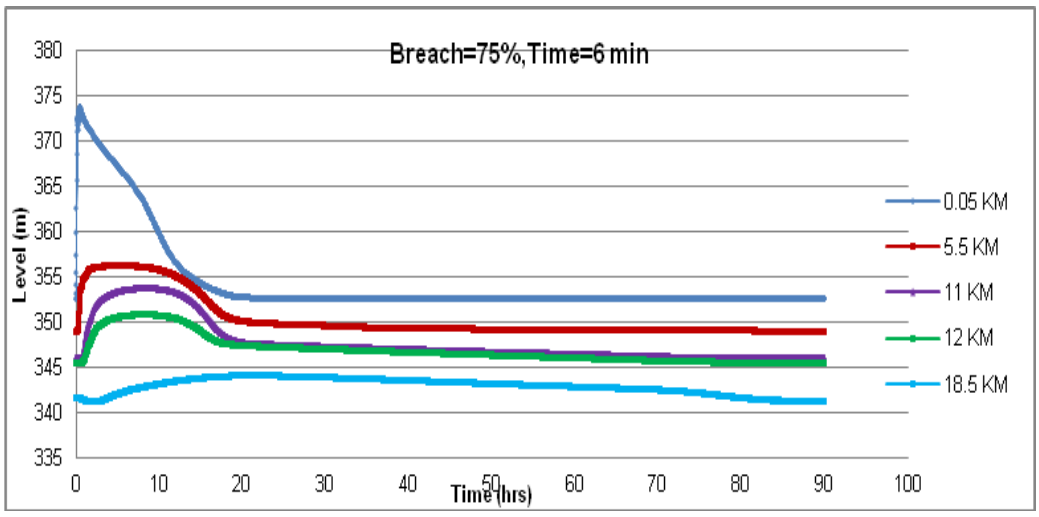
5096-DAM BREAK AND FLOOD ROUTING STUDIES FOR TILAIYA ULTRA MEGA POWER PROJECT, JARKHAND

Tilaiya Ultra Mega Power Project (UMPP) was an upcoming 4000 MW power project at Hazaribagh district, Jharkhand. The project was being developed by Jharkhand Integrated Power Limited (JIPL), which was a wholly owned subsidiary of the Reliance Power Limited. The location of project is on downstream of Tilaiya dam in the right bank of Bararkar River. A study was carried out to estimate the effect of flooding in the proposed project area in the case of eventuality of failure of the dam.

A generalized flood routing model (unsteady flow simulation), FLDWAV developed by National Weather Services (NWS), U.S.A was used to simulate the problem. Storage (level-pool) routing was used within the reservoir with the tail water elevations computed via the Saint-Venant equations, and dynamic routing used through the 21 km routing reach downstream the dam. It was assumed that the dam breaks when the level of water reaches top of the dam and start over topping. The downstream boundary condition was taken as normal flow computed from Manning's equation.

Nine different dam break simulations with different breach parameters were carried out. The time of breach taken were 0.1hr (6 min), 0.15 hr (9 min) and 0.2 hr (12 min). The widths of breach taken was a lower value of 25%, middle value of 50% and a higher value of 75% of length of dam. A sensitivity analysis was carried out to obtain an optimum result from the study with different permutations and combinations of time of breach and width of breach.

The study results indicated that the expected maximum water level in river Bararkar near the proposed colony area, 5.5 km downstream of Tilaiya dam due to the breach of dam by overtopping would be 357.01 m above MSL. At the plant site, 12 km downstream of the dam, the estimated maximum water surface elevation due to dam breach would be 351.12 m above MSL. The sensitivity to width of breach of dam and time of breach were negligible at these locations. These levels at river Barakar can be used as downstream boundary condition in the studies for fixing up the safe grade elevations for colony and power plant area.



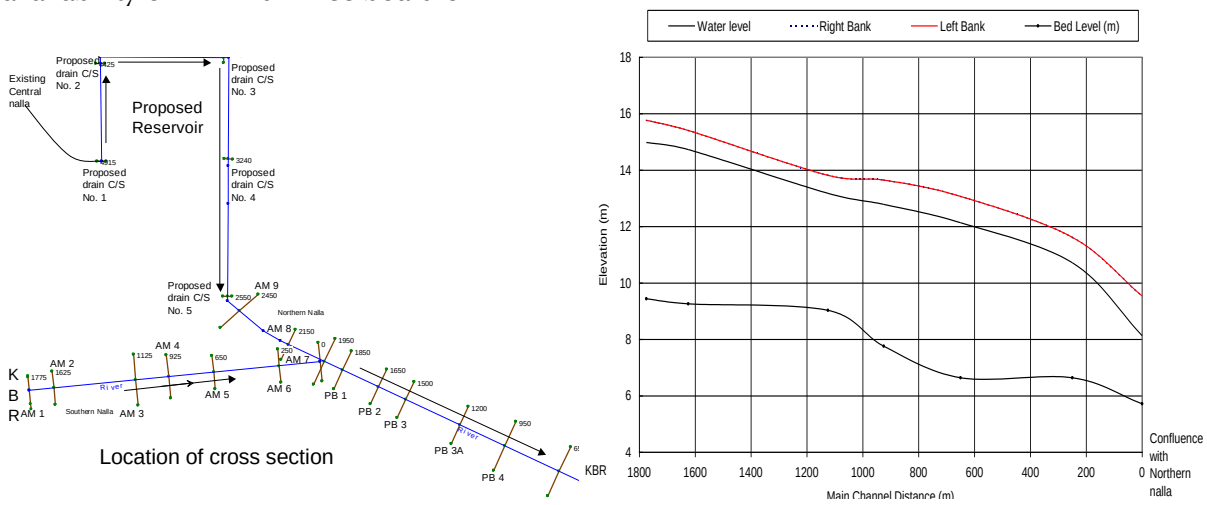
Water level Hydrograph after Dam break at selected cross sectional locations D/s of dam

5102-DAM BREACH STUDIES FOR PROPOSED RESERVOIR OF VISAKHAPATNAM STEEL PLANT, ANDHRA PRADESH

Visakhapatnam Steel Plant (VSP) campus is spread over an area of 9600 ha. The campus included main plant, township and other ancillary structures like schools, college buildings etc. VSP, a 3.4 MTPA capacity plant was being expanded to 6.3 MTPA capacity and it was proposed to further expand to 11 MTPA. The water requirement was met from Kanithi Balancing Reservoir (KBR) spread over an area of 267 ha. (660 acres) and having a storage capacity of 16.93 Mm^3. The water requirement under post expansion scenario was proposed to be catered by construction of additional storage reservoir. VSP had requested CWPRS to conduct dam break studies for the proposed reservoir. Cognizance of earlier report was also taken for considering the dam breach hydrograph resulting from failure of existing KBR. 1-D mathematical model for routing the flows were carried out for computation of flood levels using existing cross sections of northern and southern nalas. Two college buildings viz Alfa and Chaitanya are located adjacent to the new reservoir. The ground level is approximately 13.5m in the vicinity of college buildings.

The breach hydrograph for proposed reservoir having a peak flow of 363.8 cum/s was derived from dam break studies. This hydrograph was added at cross section AM9 located on northern nala near south east corner of proposed new reservoir. Breach hydrograph due to failure of KBR was added at upstream of southern nala near southeast corner of KBR. Under the occurrence of failure of both the reservoirs the area would be heavily flooded resulting in submergence of both the college buildings as well as the habitations in the vicinity. As a remedial measure under this situation, two alternatives were suggested, one shifting of the two college buildings to higher elevation, another construction of ring bund around the structure with top of the bund above the maximum flood level

However, considering the safety of life of large number of students and staff members, VSP authorities may consider the first alternative of shifting the college buildings to higher elevation. Further studies were carried out with the modifications in cross sections of northern and southern nalas. Simulation runs were taken for the same boundary conditions. All other parameters were retained as in the earlier runs and water surface profiles under new scenario were derived. Cross sections of the remodeled northern nala beyond PB6 towards sea have been derived. The sections with bed width of 80m and a side slope of 1:3 have been derived. The top of embankment was decided in order to ensure availability of minimum free board of 1m.



Schematic diagram for mathematical model and water surface profile for southern nala

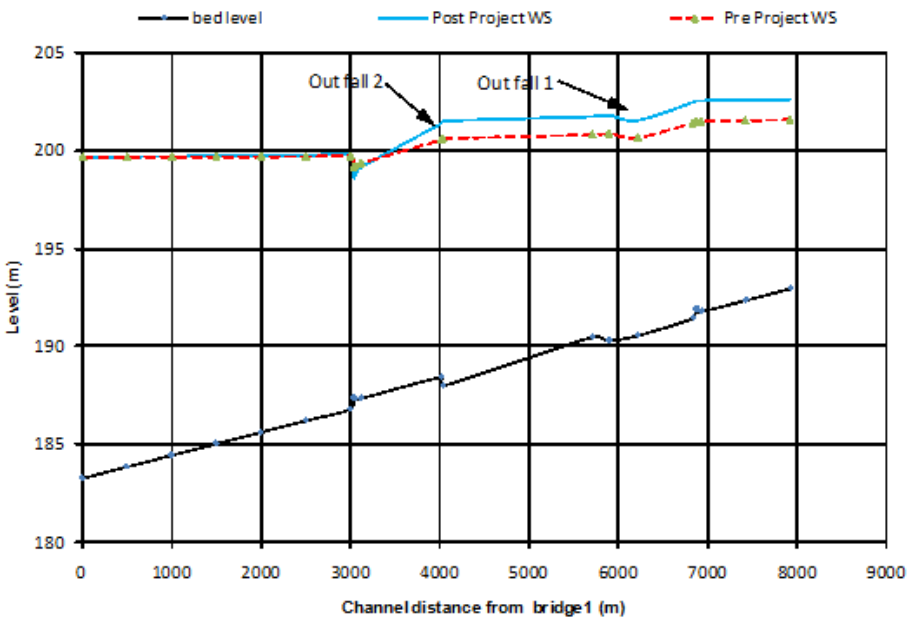
5105-MATHEMATICAL MODEL STUDIES FOR SAFE GRADE ELEVATION DETERMINATION FOR PROPOSED INTEGRATED POWER PLANT NEAR LARA, CHHATTISGARH

M/s. NTPC Ltd has proposed to set up a Thermal Power Plant near Lara, Chhattisgarh. The power plant would have an installed capacity of 4000 MW. The plant would be located on right bank of river Kelo near Lara village at a distance of about 21 km from Raigarh. The proposed Thermal Power Plant of NTPC was spread over an area of 1044 hectares. The studies were conducted to assess the SGE for the plant.

The analysis of rainfall was carried out for five rain gauge stations using Gumbel Extreme Value (GEV) distribution. The average rainfall depth of 313.34 mm was derived from daily maximum rainfall of five rain gauge stations using Thiessen polygon method. Unit hydrograph was developed as per CWC guidelines. The hourly rainfall depths of 12.95 cm, 4.15 cm, 1.51 cm, 0.85 cm, 0.41 cm and 0.63 cm were derived from design rainfall of 31.33 cm and storm of 6 hrs duration as per CWC guidelines. Storm hydrograph was derived by convolution of the ordinates of unit hydrograph with rainfall depths.

This data was used as input for the 1-Dimensional mathematical model (HEC-RAS) for simulating the flow through nala for pre and post project scenarios. Peak discharge of storm hydrograph derived for catchment area of Chapora nala was considered as upstream boundary and HFL at confluence of Chapora nala with river Kelo was considered as downstream boundary.

The water levels in project area were derived with consideration of bed slope, depth of water and free board of drainage channels. The safe grade elevation was recommended as RL 205.55 m, RL 206.71 m, RL 207 m, RL 204 m and RL 202 m for plant stage I, Plant stage II, township, ash dyke I and ash dyke II respectively.



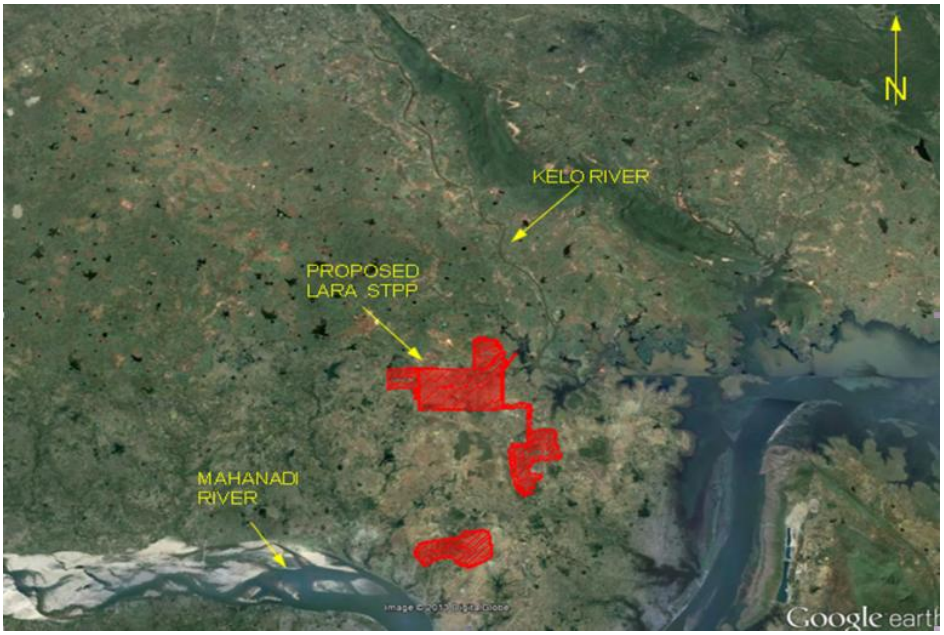
Water surface profile of chapora nala

5106-AREA DRAINAGE STUDIES FOR PROPOSED INTEGRATED THERMAL POWER PROJECT NEAR LARA, CHHATTISGARH

M/s. NTPC Ltd had proposed to set up a Thermal Power Plant near Lara, Chhattisgarh. The power plant was to have an installed capacity of 4000 MW. The plant was located on right bank of river Kelo near Lara village at a distance of about 21 km from Raigarh. The proposed Thermal Power Plant of NTPC was spread over an area of 1044 hectares. Studies were conducted for area drainage of the plant area at CWPRS.

The analysis of rainfall was carried out for five rain gauge stations using Gumbel Extreme Value (GEV) distribution. The average rainfall depth of 247 mm was derived from daily maximum rainfall of five rain gauge stations using Thiessen polygon method. Synthetic Unit hydrograph was developed as per CWC guidelines. The hourly rainfall depths were derived from design rainfall of 24.70 cm by CWC guidelines. Storm hydrograph was derived by convolution of the ordinates of unit hydrograph with rainfall depths.

The discharge components for plant, township, ash dyke I and II were derived using rational method. These components of discharge were added into discharge from adjoining area to obtain design discharge of storm water drainage (SWD) channels. The cross sections of SWD channels were derived for design discharge using bed slope of 1:2500 and Manning's roughness constant of 0.02. SWD channels leading storm water from plant, township, ash dyke I and II and adjoining area to river Kelo through Chapora nala and to river Mahanadi were derived for four different outfall points viz. outfall 1, outfall 2, outfall 3 and outfall 4 with rectangular cross section. Cross sections were designed considering smooth lining similar to surface of smooth finished concrete for sides and bed.

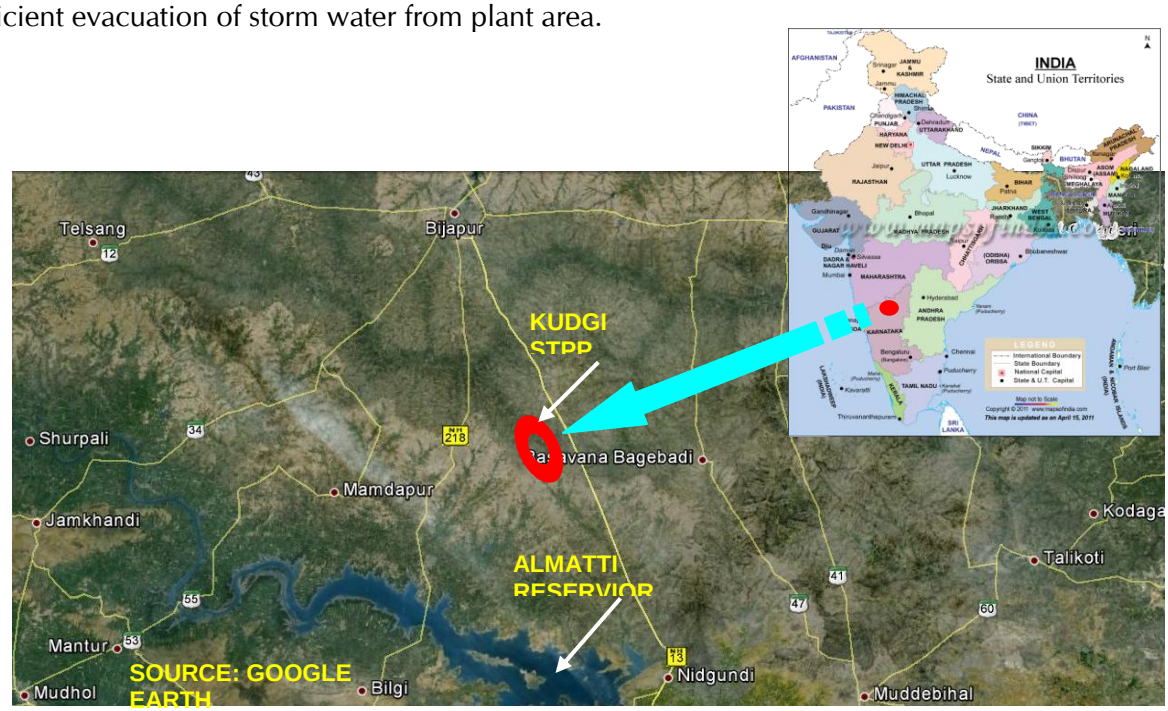


Location map of site plan of Lara thermal power plant

5124-AREA DRAINAGE STUDIES FOR KUDGI SUPER THERMAL POWER PROJECT OF NTPC, KARNATAKA

M/s NTPC have proposed to build and operate a Super Thermal Power Project (STPP) with an installed capacity of 4000 MW (5 x 800 MW) near Kudgi village in Bijapur district of Karnataka. NTPC requested CWPRS to conduct the studies on Area drainage and determination of Safe Grade Elevation (SGE) for the STPP. The Kudgi STPP area has three functional parts i.e. main plant, ash pond and township. The proposed project site is located at a distance of about 40 km from Bijapur city and located north of Almatti reservoir. South Central Railway of Bijapur branch line is running between main plant area and ash pond areas. The project area is situated on elevated portion of land in the catchments of tributaries joining river Krishna. Streams originated from the plant area flow east and join Hire Halla/Parvatikatta Halla which directly outfalls into the Almatti reservoir. The available rainfall data (daily and hourly) were procured by CWPRS from India Meteorological Department (IMD). The Extreme Value Analysis (EVA) of the daily and hourly rainfall data was carried out using EV-I distribution and 1-day and sub-daily maximum rainfall for different return periods were estimated.

Catchments influencing the project area were delineated and synthetic unit hydrographs (SUH) were developed for sub-catchments. Using the SUH and extreme rainfall for 100-year return period, extreme flood from each sub-catchment were estimated. NTPC provided survey data on spot elevations in plant area, general layout plan of the plant and cross sections (CS) of streams from plant and ash pond areas, Hire Halla upto Almatti reservoir and Ere Halla upto Asangi Kere Tank. Using the CS data of streams and adopting 1-D flood routing model HEC-RAS the estimated extreme flood was routed through the stream network to estimate Highest Water Level (HWL) at different locations of interest in the project area. Using the HWL estimated and the length and slope of storm water drain from plant and ash pond areas, the Safe Grade Elevation (SGE) was determined. The SGE for plant area determined was 571.00 m and similarly the SGE (top of overflow bund) for ash pond was 574.00 m. Based on the general layout plan and the SGE for plant, the storm drains were designed for efficient evacuation of storm water from plant area.



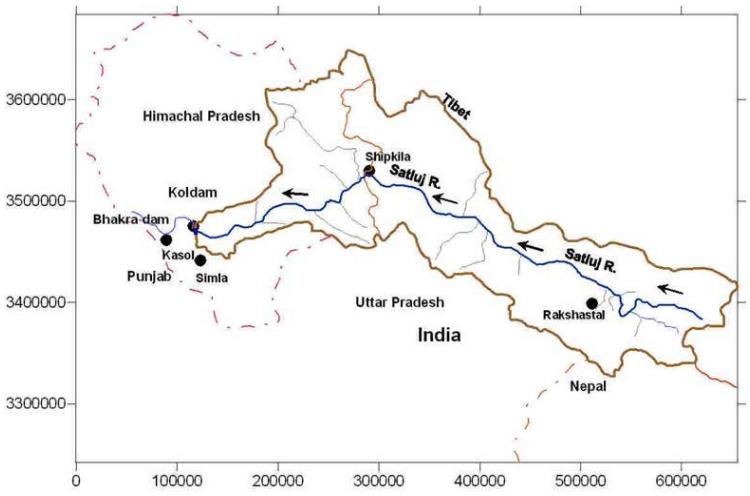
Location map of Kudgi STPP

5128-DEVELOPMENT OF FLOOD FORECASTING MODEL FOR KOL DAM

NTPC proposes to generate 800 MW hydropower by building and operating of Kol dam Hydro-Electric Project on river Satluj about 6 km upstream of existing Dehar Power Station of BBMB, in Bilaspur district, HP. In this regard, NTPC approached CWPRS to conduct two studies viz., (i) Installation of Hydrometric network for Kol dam and (ii) Development of mathematical model for flood forecasting for Kol dam. Out of these, the study under item (i) was completed and technical report (TR 4196) submitted in January 2005, suggesting hydro-meteorological installation in the catchment which comprises four rain gauge stations. For study under item (ii) NTPC explored various modalities of obtaining flow data from different agencies such as BBMB, CWC or a standalone system. Finally, a standalone hydrometric system by NTPC with upstream flow data forecast on Satluj at Pandoa by CWC was chosen. The flood forecasting model was developed for Satluj river system from Pandoa to Chhaba river gauge and Kol dam reservoir downstream.

The flood forecasting model was developed with three main processes, viz., (i) rainfall-runoff for ungauged catchments adding to Satluj or Kol dam reservoir (using Clark's method), (ii) flood routing for upstream reach of Kol dam i.e. Pandoa to Chhaba adopting Muskingum method and (iii) reservoir routing adopting mass balance. The average catchment rainfall was computed using Thiessen method based on the real time rainfall data available during forecasting.

The model was developed using C++ programming language to operate in two modes i.e., (i) test mode; for testing the model with past data and (ii) forecast mode; to issue warnings during forecast operations. The model is developed in modular fashion for possible additions and modifications. The forecast lead time could be computed by flood translation time and also based on the validity of flows provided for Pandoa by CWC gauge site. The model has provision which provides option for operation of Kol dam level controls for releasing outflows. Before arriving at forecast the project authorities can take a set of trials for an optimum value of reservoir level by deciding the outflow from Kol dam. Model outputs are written separately in four output files namely; (i) detailed output file, (ii) executive output file, (iii) forecast output file and (iv) dam office output file. This report is divided into two volumes; volume I details, the scope of studies, model philosophy, hydrology of Kol dam system, model development, merits and limitations with cautions for use of model and sample list of model input and output files. Volume II presents user manual, system requirements and input data entry formats for the model.



Map of Sutluj river basin upto Bhakra dam

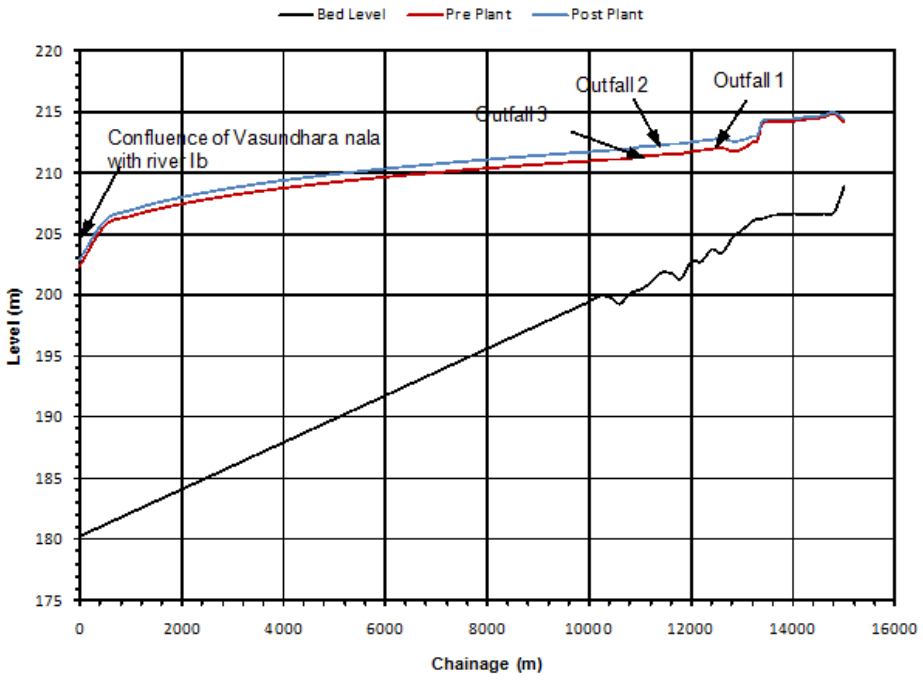
5130-MATHEMATICAL MODEL STUDIES FOR DETERMINATION OF SAFE GRADE ELEVATION FOR PROPOSED INTEGRATED POWER PLANT NEAR DARLIPALI, DIST. SUNDARGARH, ODISHA

M/s. NTPC Ltd had proposed to set up a Thermal Power Plant near village Darlipali, located in Dist. Sudergarh, Odisha. The power plant had an installed capacity of 3200 MW spread over an area of 712 hectares. Studies were conducted to assess the Safe Grade Elevation (SGE) for the power plant.

The analysis of rainfall was carried out for five rain gauge stations using Gumbel Extreme Value (GEV), Log Normal (LN) and Log Pearson (LP) distributions for return period of 25, 50 and 100 years. A review of results indicated that A^2 statistics for GEV and LN were less than the critical value. The 100-year return period rainfall depth of 44.16 cm obtained from GEV analysis was used for determination of Safe Grade Elevation. Consequently, the areal rainfall depth of 33 cm was estimated from daily maximum rainfall depth of 44.16 cm and storm duration of 8 hours. Further, hourly rainfall depths were derived as 16.29 cm, 3.09 cm, 3.75 cm, 2.76 cm, 2.10 cm, 1.44 cm, 1.44 cm and 0.45 cm from design areal rainfall depth of 33 cm and storm duration of 8 hrs as per CWC guidelines. Storm hydrograph was derived by convolution of ordinates of unit hydrograph with hourly rainfall depths.

This data was used as input for the 1- Dimensional mathematical model (HEC-RAS) simulating the flow through nala for pre and post project scenarios. Peak discharge of storm hydrograph derived for catchment area of Vasundhara nala was considered as upstream boundary and FRL of Hirakud reservoir was considered as downstream boundary.

The water levels in project area were derived with consideration of bed slope of drainage system, depth of water in the storm water drains and free board provided for free flow condition. On the basis review of results the Safe Grade Elevation was recommended as RL 221 m for plant at south side, RL 225 m for plant at north side, RL 227 m for township and RL 220 m for ash dyke area.

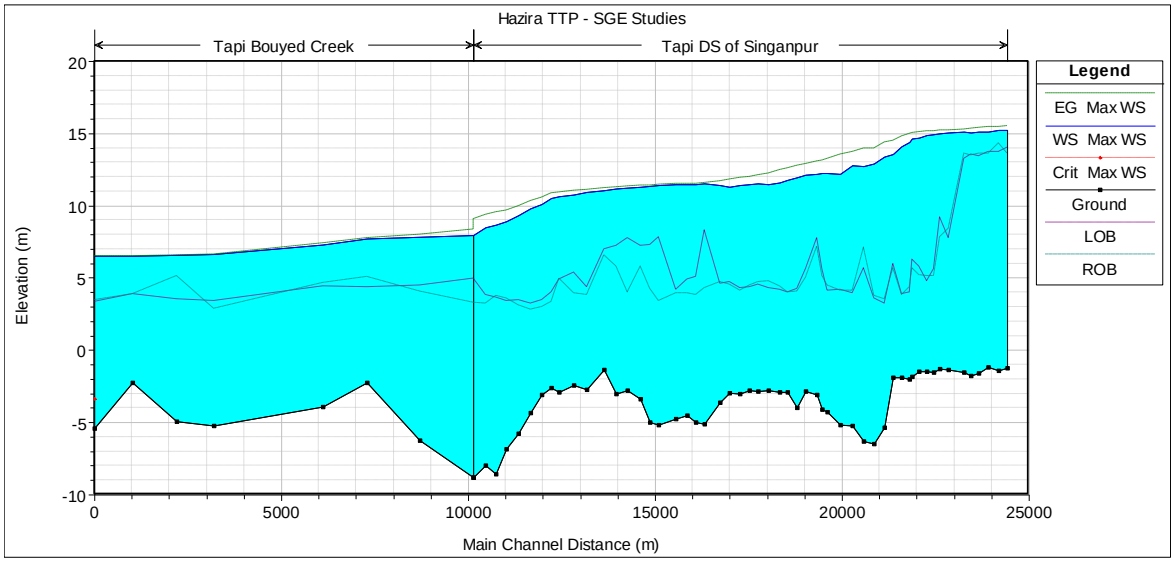


Water surface profile of Vasundhara nala

5131-STUDIES FOR DETERMINATION OF SAFE GRADE ELEVATION FOR TRIANGULAR PLOT OF RIL AT HAZIRA

The Reliance Industries Limited (RIL) is proposing to generate 380 MW power by building and operating thermal power plant at their Triangular plot at Hazira, Gujarat. In this regard, RIL have requested WAPCOS to conduct various studies for the said project. In turn WAPCOS requested CWPRS to conduct the studies for determination of Safe Grade Elevation (SGE) for the triangular plot at Hazira. Accordingly CWPRS undertook and carried out the studies.

Site inspection of the RIL triangular plot and surroundings area was carried out by CWPRS officers to comprehend the existing system and to collect the field data. Discussions were also held with RIL project officials and WAPCOS officers. Wherein, it was decided to determine the SGE for the triangular plot by considering the highest observed 2006 flood in Tapi river and route this flood hydrograph under unsteady condition with downstream boundary as observed tide data. 1-D hydraulic flood routing model HEC-RAS was adopted for estimating the Highest Water Level (HWL) in estuary and near Triangular plot. The upstream boundary was considered as Tapi at Singanpur weir upto which the tidal effect was observed. As the survey data on river sections, especially for the estuarine part in Dumas creek and Hazira creeks of Tapi were not sufficient, these were extended by using topographic information from toposheets, admiralty charts and maps from google earth. This apart, the storm surge effect was also considered in addition to tide in estimating HWL in estuary at points of interest near project area. 1-D flood routing model was calibrated with 1998 flood in Tapi river. From the HWL and project layout plan and considering the slopes of storm drains and free boards, SGE for the said triangular plot was determined as 6.90 m above MSL (or 9.20 m w.r.t. CD). The water surface profile generated from the model is given in Figure, without considering the storm surge effect.

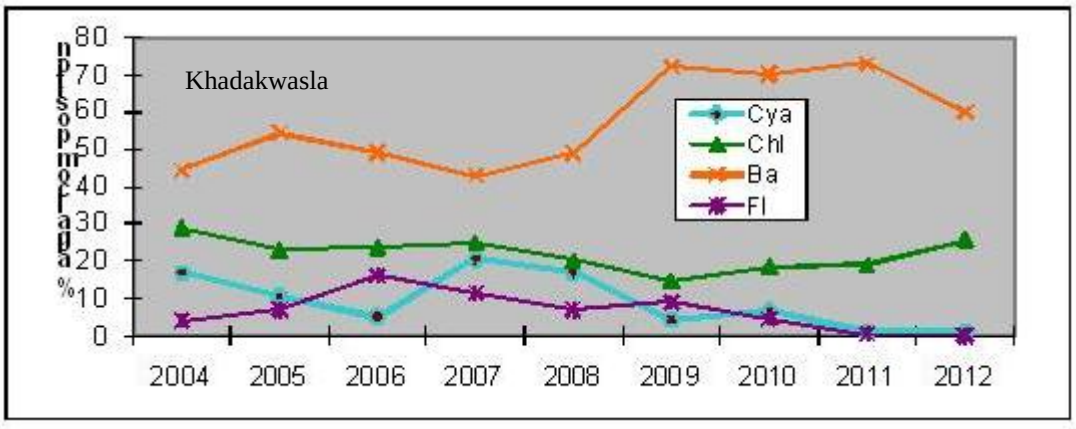


Water surface profile for Tapi and Hazira creek - without storm surge

5152-TRENDS IN WATER QUALITY OF KHADAKWASLA RESERVOIR

Khadakwasla reservoir water has been in use for drinking and irrigation since 1879. In recent years, as there has been an increase in the anthropogenic activity in the catchment area, the present work was carried out during October, 2003 to September, 2012 to study trends in the water quality. Six sampling locations comprising right bank, left bank and downstream of dam were selected, for collection of in-situ data, water and biological samples. The objectives of the present study are to evaluate inter-relationship between physico-chemical and biological aspects of water and to develop a mathematical model as a tool for sustainable management of the reservoir water quality. The overall rising trend in Conductivity is indicative of increased activities and changed land-use pattern in the catchments that cause more salts to be driven to the water body. Progressive increase in planktonic primary productivity observed in the reservoir indicates the vulnerability of the reservoir for the eutrophication. A sudden spurt in the phytoplankton population was observed during monsoon season and the maximum average phytoplankton density observed was of the order of 17417 organisms/lit dominated by diatoms Bacillario phyceae (50%), followed by green algae Cloro phyceae (24%). Figure shows increasing trend of diatoms. The middle portion of the reservoir was found to be more productive. Water Quality Index computed by considering observations of 19 water quality parameters, remained between 81 to 91 showing 'good' quality. The data collected over the years from 2003 to 2012 enabled us to identify the trends and correlate these changes to the type and extent of developmental activities in the catchment area. Such systematic water quality assessment helps in planning utilization, anti-pollution and conservation strategies for sustainable use of an aquatic ecosystem. To our knowledge, this is the first methodical water quality study on Khadakwasla reservoir.

Water quality modelling is the predictive tool to understand the future scenario of water quality. For the reservoirs already showing the symptoms of quality-deterioration, such predictive study for their restoration is the need of the hour. CWPRS can take up such study.



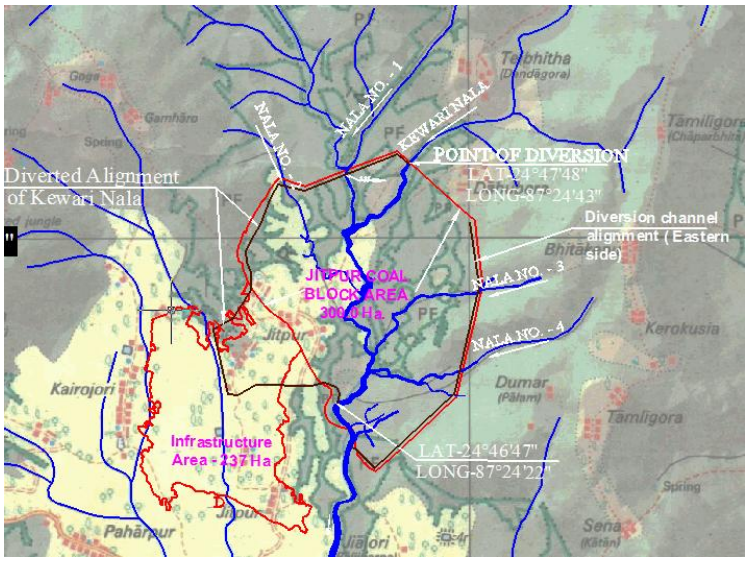
Temporal variation in annual mean values of phytoplankton components

5162-STUDY FOR DIVERSION OF KEWARI NALLA PASSING OVER THE JITPUR COAL BLOCK AT GODDA, JHARKHAND FOR M/S JINDAL POWER LTD.

M/s Jindal Power Limited (JPL) was establishing a Thermal Power Plant (TPP) of capacity 2 x 660 MW in Godda district of Jharkhand. The required coal was to be catered from Jitpur Coal Block proposed for open cast mining operations located 10 km from TPP in Godda district. The total area of coal block was 300 ha that had been allocated to M/s JPL, by Ministry of Coal, Government of India. Kewari Nala, a tributary of Gumani River was flowing in north-south direction through this mine area, which practically divides the area in two halves. Large amount of coal was underlying below the bed of nala at a depth of more than 60 – 70 meters. Therefore, diversion of the main Kewari Nala was planned along the western boundary of the coal block.

Floods from the upstream catchments influence the flow in the reach of Kewari nala under consideration. The peak flood discharge of different return periods were estimated using Synthetic Unit Hydrograph (SUH) method as well as rational method taking into consideration of catchment area, catchment characteristics and estimated rainfall intensities for 25, 50 and 100 year return periods. The topography of nala reach under consideration was simulated using cross section data. The model runs were taken for predicting flood levels under existing conditions and for diverted nala under different return period floods as upstream boundary conditions. The HEC-RAS Beta 4 Version for the computation of water level was used for these studies. Keeping present requirements in view, i.e. only hydrodynamic studies for water flow simulation was adopted.

Based on the analysis of Meteorological data, topographical data and result of model studies, it was found that the design parameters of diversion plan of Kewari nala in Jitpur coal block suggested by M/s Nano consultants Pvt. Ltd were suitable and the diversion of Kewari nala for a length of 4.05 km along the western boundary of the coal block seems to be feasible. It was seen from the results of mathematical model that there was no significant change in water levels under existing and proposed diversion conditions for the common reach of Kewari nala in the downstream of the coal block area upto Gumani river.



Coal block map indicating Kewari nala, nala 1,2,3 and 4

RESERVOIR & APPURTENANT STRUCTURES

5061-HYDRAULIC MODEL STUDIES FOR RESERVOIR SEDIMENTATION AND FLUSHING FOR LUHRI H.E. PROJECT, HIMACHAL PRADESH

Luhri Hydro-electric project is situated in Himachal Pradesh about 100 km from Shimla on river Satluj. The project utilizes a gross head of 220 m for generation of 775 MW of electricity. The project comprises of a concrete gravity dam with a sluice spillway at Nirath, 38.14 km long twin head race tunnels of 9.0 m dia on the right bank of river and an underground power station near Chaba with four turbine generator units. The desilting in Luhri H.E. Project is proposed to be achieved by utilizing 2 km length out of the total length of 7 km. The downstream stretch of reservoir will act as a desilting basin and would be flushed periodically. In addition, two diversion tunnels (DT) each 2 km long, have also been planned to pass the majority of excess flood water of the order of 1000 m^3/s when the flow exceeds the generation requirement of 480 m^3/s, thus improving the desilting process.

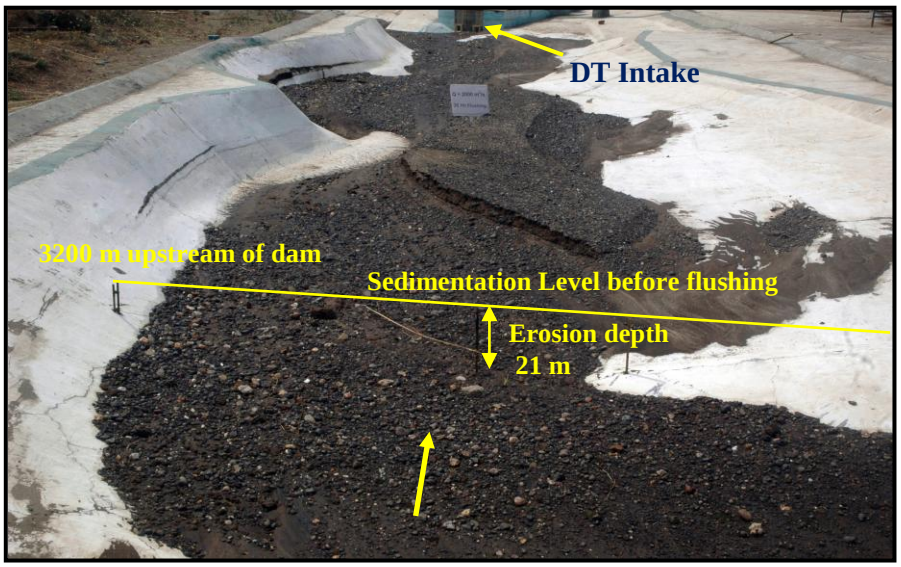
The studies were carried out on 1:60 scale geometrically similar 3-D Comprehensive model. Reservoir reach of 4 km upstream and 0.8 km downstream was reproduced to assess whether the proposed arrangement of using 2 km downstream portion of reservoir to act as a 'desilting basin' is effective or not. Hydraulic performance of the diversion tunnels for transporting silt, the efficiency of diversion tunnel intake and its location were also studied.

View of model

Model observations show that, diversion tunnels are effective in diverting a part of suspended sediment directly to downstream of dam. There is a substantial reduction in forward velocity in the reservoir due to bifurcation of discharge, causing settlement of coarse and medium suspended sediment along with majority of the fine particles in the 2 km reach between diversion tunnel and the dam, which will act as a large settling tank. Bypassing of a part of incoming sediment load through diversion tunnel will help in delaying the process of sedimentation of reservoir in the dead storage, thus maintaining the live storage capacity for longer periods. Higher sediment concentrated flows can be bypassed through diversion tunnels if their intake is shifted by approximately 30 m further inside the reservoir and align it with the direction of flow. For simulation of suspended sediment, available crushed and sieved walnut shell powder having specific gravity of 1.32 was used for sedimentation studies. Hydraulic performance of diversion tunnels was satisfactory and no sediment deposition was observed inside the tunnels.

Reservoir flushing studies were carried out by laying the available khaswa (fine silt) having d_{50} of 0.23 mm as per the sediment profile supplied by SJVNL. The model was run for flushing discharges of 500 m^3/s, 1000 m^3/s and 2000 m^3/s and durations of 12 to 36 hours.

It was observed on the model that optimum conditions of flushing are reached in 12 hours and flushing is not recommended beyond 12 hours as the flushed quantities are not significant for all the other discharges and durations simulated in the model.

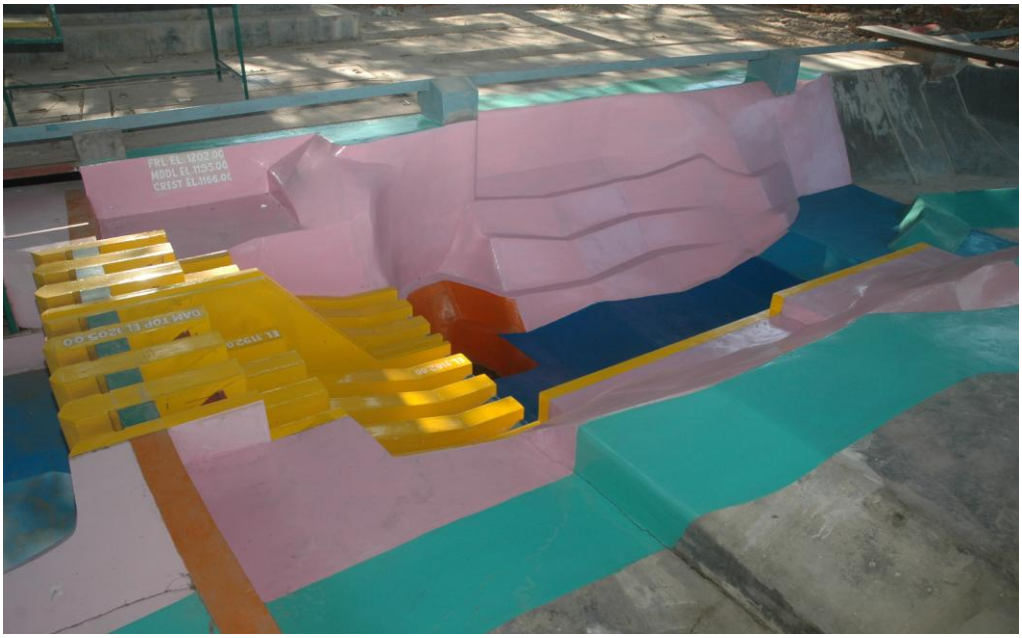


Flushing with discharge 2000 m^3/s after 36 hours

5078-HYDRAULIC MODEL STUDIES FOR SPILLWAY OF PUNATSANGCHHU H.E. PROJECT, STAGE-I, BHUTAN, 1:70 SCALE 3-D COMPREHENSIVE MODEL

Punatsangchhu-I H.E. Project is located on Punatsangchhu River in Wangdue Phodrang Dzongkhag in Western Bhutan. The project envisages construction of a 136 m high concrete gravity diversion dam to generate 1200 MW of power utilizing a net head of 343 m at an underground power house. The main spillway consists of 7 sluices of dimensions 8 m (W) x 15 m (H) to pass probable maximum flood of 11,500 m^3/s and Glacial Lake Outburst Flood (GLOF) of 4,300 m^3/s. The MWL / FRL are at El.1202 m and the MDDL is at El. 1195 m. The crest of the spillway is at El. 1166 m. An auxiliary spillway in the form of ogee with crest at El. 1198 m is equipped with vertical lift gate of size 4 m (W) x 4 m (H) at the centre of main spillway. Ski -jump bucket has been provided as energy dissipator for both the spillways. A pre-excavated plunge pool is provided downstream of the ski-jump bucket. The water conductor system at the left bank comprises of four power intakes carrying a discharge of 462.65 m^3/s, a 9 km long 10 m diameter circular concrete lined head race tunnel carrying discharge of 385.54 m^3/s and a 128.5 m high, 24.5 m diameter underground restricted orifice type surge shaft. The tail race system comprises of a 1311 m long and 10 m diameter D-shaped tail-race tunnel.

The studies were conducted to assess performance of the ski jump bucket and the flow conditions downstream of the spillway on 1:70 scale comprehensive model by reproducing the river cross-sections indicating rock line downstream of dam axis from Ch. 120 to 660 m, reproducing right training wall and recessed left bank in the plunge pool area. The flow was seen overtopping intermittently at the joint of pier and training wall at Ch. 50 m for the design discharge of 15,800 m^3/s. The ski jump jet of right end span was seen hitting the upstream face of step of right training wall due to its lateral spread and therefore it is suggested to increase the height of training wall from El. 1162 to El. 1174 to contain the flow in the bucket region. The upper nappe of ski-jump jet was seen riding over the right training wall in the plunge pool area with top at El. 1174 m for discharges of 6,900 m^3/s (60% of PMF) and above. Hence, the top elevation of right training wall downstream of ski-jump bucket needs to be raised to El. 1180 m to match with the existing maximum height of right training wall to contain the ski jump jet. The performance of ski jump bucket was satisfactory for entire range of discharges for both gated and ungated operation of spillway. There was substantial improvement in the performance with dressing of river overburden and consequent lowering of tail water levels. Forward flow along the right training wall in the plunge pool and return flow along recessed left bank was observed due to unsymmetrical water way downstream of spillway. The return flow swirls in the stagnant water in the artificial pool just downstream of spillway on the left bank forming strong eddies. These eddies are totally undesirable as they may cause scooping out of the excavated hill slope causing slope destabilization, which may lead to land slide. Provision of a training wall from bucket lip to ch. 170 m i.e. up to the existing recessed left bank may avoid the churning of flow in the stagnant pool.



Dry model showing dressed downstream portion

Flow condition downstream of spillway for 15,800 m3/s

5085- HYDRAULIC MODEL STUDIES FOR DISCHARGING CAPACITY FOR FULL AND PARTIAL GATE OPERATION OF PARE DAM SPILLWAY, ARUNACHAL PRADESH1:60 SCALE 3D COMPREHENSIVE MODEL

The Pare H.E. Project is planned as a run-of-river scheme on the Dikrong / Pare river downstream of the power house of the first stage of Ranganadi H.E. Project in Papumpare district of Arunachal Pradesh. The project envisages construction of a 78 m high concrete gravity diversion dam, about 3 km long water conductor system and a surface powerhouse with an installed capacity of 110 MW. The breastwall spillway has been provided to pass the flood as well as to flush the sediment deposited in the reservoir into the river downstream. The spillway is designed to pass the maximum design outflow flood of 5000 m^3/s through 3 orifice openings of size 10.4 m (W) x 14 m H with crest level at El. 216 m. The FRL and MWL have been fixed at El. 245.15 m and 246.215 m respectively. Radial gates have been provided at the downstream face of breastwall for controlling the outflow discharge. A ski-jump bucket of 30 m radius and 35^o lip angle with pre-formed plunge pool is provided for energy dissipation.

Hydraulic model studies conducted for original design of the breastwall spillway on the 1:60 scale 3-D comprehensive model indicated that the entire opening of orifice spillway was not effective as the water surface was not following the breastwall bottom profile. This resulted in inadequate discharging capacity. Performance of the ski-jump bucket was also not satisfactory. Hence, revised design of the bottom profile of breastwall and spillway profile with ski-jump bucket were evolved jointly by CWPRS and design engineers to improve the performance of spillway. The studies conducted on revised design of the spillway with pre-formed plunge pool indicated improvement in the discharging capacity and satisfactory performance of ski-jump bucket as an energy dissipator. Further studies were conducted with erodible river bed and banks to assess the maximum depth of scour and scour pattern downstream of spillway for gated and ungated operation of spillway for various discharges upto the design discharge of 5000 m^3/s. Based on the scour studies, the size of the plunge pool proposed was 49.2 m (W) x 30 m (L) with bottom at EL. 180 m located between ch. 150 m and 180 m from dam axis. Longitudinal slopes upstream and downstream of plunge pool may be kept at 2^0 and 18^0 respectively. Study with erodible river bed indicated that after formation of scour hole, the excess energy of the flow gets dissipated and the flow in the river downstream would remain sub-critical with velocity of the order of 3 to 7 m/s implying the necessity of pre-formed plunge pool. The studies were also conducted for assessing the discharging capacity of the spillway for partial and equal gate operation of all the three gates with gate opening ranging from 1 m to 13 m for various reservoir water levels up to FRL El. 245.15 m. These results would be useful in planning the operation of spillway.

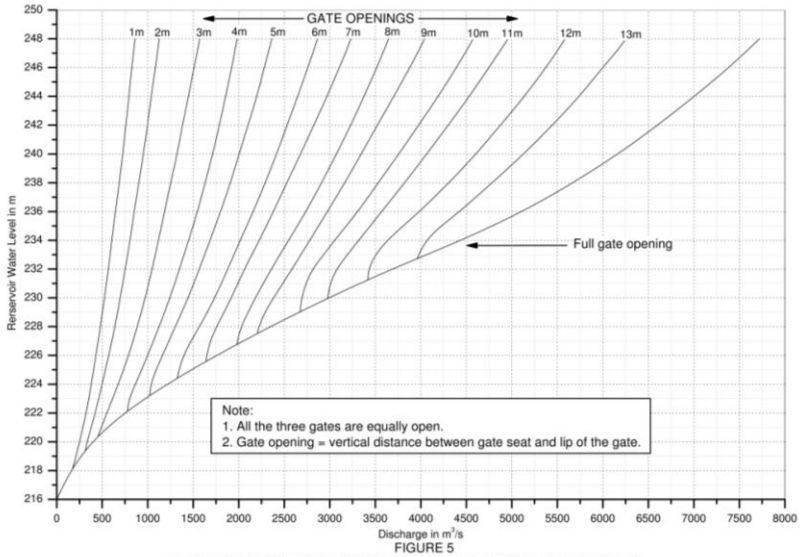


FIGURE 5
DISCHARGEING CAPACITY CURVE FOR FULL AND PARTIAL GATE OPENING

Discharging capacity curves for full and partial gate operation

Flow conditions downstream of the spillway for partial gate operation
Q= 5000 m^3/s, FRL El. 245.15 m

5121-HYDRAULIC MODEL STUDIES FOR DESILTING CHAMBER FOR MANGDECHHU H.E. PROJECT, BHUTAN

The Mangdechhu H.E. Project is located on River Mangdechhu in Trongsa Dzongkhag district in Central Bhutan. The installed capacity of the project was proposed to be 720 MW (4 units x 180 MW each) and had a gross head of 733.0 m. It consisted construction of a 114 m high (from deepest foundation level) concrete gravity dam to divert a river flow of 135.7 m^3/s (67.85 m^3/s per intake x two Nos.) into a 13.56 km long, 6.5 m dia horse shoe shaped concrete lined Head Race Tunnel (HRT) through the two units of desilting chambers. The proposed size of each unit of the desilting chamber was 300 m (L) x 14 m (W) x 17.7 m (D). The desilting chambers had been proposed to remove suspended sediment particles coarser than 0.2 mm size and maximum sediment concentration of 5000 ppm. Design discharge for each chamber was 59 m^3/s and flushing discharge was 8.85 m^3/s.

Considering the suspended sediment data supplied by NHPC Ltd., for the years June 1995 to December 2006 for river Mangdechhu at Bjizam about 7.5 km upstream of dam axis, the percentages of coarse and fine sediment had been worked out to be 36.2%, 63.8% respectively. The model was constructed to the scale of 1:25 G.S. The average settling efficiency of the desilting chamber based on analytical method was worked out to be 81% and on actual experimental basis was 88.29% for the sediment used in the model. Based on the analytical estimation the settling efficiency for particle size coarser than 0.2 mm was worked out to be 90%. Thus, the desilting chamber of proposed size was adequate for 90% settlement of sediment having 0.2 mm diameter and above. The inlet transition with a bed slope of 1: 2.33 required slight modification.

It was proposed that two different bed slopes of 1: 3.569 for upstream length of 16.74 m and 1: 1.374 for the remaining length of 8.26 m could be provided. The size of the flushing tunnel below the desilting chamber was found to be adequate in drawing the required flushing discharge for efficient transport of the sediment deposited in the desilting chamber. The performance of the outlet transition was found to be satisfactory. The size of settling trench was adequate to accommodate the dunes formed between successive openings and the openings provided in the model for flushing the settled sediment were working efficiently.

Model of desilting chamber

5136-2D SECTIONAL MODEL STUDIES FOR SPILLWAY OF UJH BARRAGE, J&K

The Ujh barrage, J&K having a waterway of 356 m was commissioned in 1980. The barrage was designed for a discharge of 5000 m^3/s. During 1987, barrage experienced a high flood of 8835 m^3/s resulting in damage to gates, glacis, and cistern portion of the spillway. In view of this, the design flood was revised to 8400 m^3/s by CWC and proposed to extend waterway by another 322 m on left side. Studies were conducted at CWPRS on a 3-D composite physical model and a total waterway of 462 m was recommended. Project authority requested CWPRS to assess the adequacy of energy dissipation arrangement after extension of barrage. 2-Dimensional physical model studies were conducted by reproducing one full bay and two adjacent half bays to a geometrically similar scale of 1:40 in a 0.9 m wide flume. Experiments showed that for the discharge intensities up to 21.46 $m^3/s/m$, corresponding to a discharge of 5000 m^3/s, the jump was found to form on the sloping glacis i.e. the performance of the existing stilling basin was found to be satisfactory because of provision of end sill. For the highest discharge intensity of 37 m^3/s corresponding to a revised design discharge of 8400 m^3/s, the hydraulic jump is sweeping out of the stilling basin. The project engineers were advised to keep a watch on this phenomenon and its effect on the immediately downstream of end sill may be surveyed regularly (under water) to rule out any possibility of development of scour holes leading to piping.

Flow conditions/ water surface profile for a discharge intensity of 37 m^3/s

5145-HYDRAULIC MODEL STUDIES FOR REVISED DESIGN OF PUNATSANGCHHU-I DAM SPILLWAY, BHUTAN1:50 SCALE 2-D SECTIONAL MODEL

The Punatsangchhu-I H.E. Project is planned as a run-of-river scheme on the Punatsangchhu river in Wangdue Phodrang district of western Bhutan. The project is located in a gorge about 7.0 km downstream of the Wangdue bridge. The project envisages construction of a 136 m high and 279 m long concrete gravity diversion dam with top El. 205 m. The sluice spillway has been provided to pass a PMF of 11,500 m^3/s along with Glacial Lake Outburst Flood (GLOF) of 4,300 m^3/s through 7 orifice openings of size 8 m wide x 15 m high with crest level at El. 1166 m. The FRL/MWL has been fixed at El. 1202 m and MDDL at El. 1195 m. Radial gates have been provided at the downstream face of breastwall for controlling the outflow discharge. The ski-jump bucket with pre-formed plunge pool is provided for energy dissipation. Besides sluice spillway, an auxiliary spillway bay has been provided with crest at El. 1198 m for passing floating debris.

The four power intakes of 6.0 m Ø are located on the left bank to carry a design discharge of 115.662 m^3/s per intake. The water conductor system consists of a 9.07 km long, 10.0 m Ø D-shaped concrete lined head race tunnel leading to a 128.5 m high surge shaft of 24.5 m Ø. Two pressure shafts of 6.0 m Ø, 433 m long take off from surge shaft and trifurcate into three branches, which feed to individual turbines of capacity of 200 MW (6 units of 200 MW each) installed in an underground powerhouse.

A 2-D sectional model has been constructed to a geometrically similar scale of 1:50 with transparent perspex sheets in a glass sided flume. Based on the recommendations from studies on original design, the breastwall profile was modified conforming to equation $X^2/40^2 + Y^2/8^2 = 1$ and based on preliminary studies on 3-D comprehensive model, the ski-jump bucket was raised by 9 m to improve the performance of energy dissipator. Hydraulic model studies were conducted to assess the performance of the spillway for various discharges up to the PMF discharge of 11,500 m^3/s. The spillway was able to pass the discharge of 15,554 m^3/s which is about 1% less than the design discharge(11,500 m^3/s PMF + 4,300 m^3/s GLOF) at FRL El. 1202 m. As such, discharging capacity of the spillway is considered to be adequate. The hydrostatic pressure distributions on the revised spillway profile, breastwall profile and pier surface are acceptable. The performance of ski-jump bucket was satisfactory for entire range of discharges for gated and ungated operation of spillway.

Flow conditions for ungated operation of spillway, Q=5750 m^3/s (50%) at RWL El. 1181.47 m

Flow conditions for gated operation of spillway, Q=5750 m3/s (50%) at FRL El. 1202 m

5146-HYDRAULIC MODEL STUDIES FOR MANGDECHHU DAM SPILLWAY, BHUTAN, 1:40 SCALE 2-D SECTIONAL MODEL

The proposed Mangdechhu H.E. Project with installed capacity of 720 MW is a run of river scheme, located on river Mangdechhu, in Central Bhutan. The project envisages construction of a 141.28 m long and 56 m high concrete gravity dam above river bed. The dam has been provided with a breast wall spillway with 4 spans 10 m wide x 16 m high, equipped with radial gates separated by 3.5 m thick twin piers. The crest level of the spillway is at El. 1702 m. The FRL is at El. 1747 m. The spillway chute has a slope of 1:10.624. The downstream profile conforms to equation $X^2 = 162\ Y$ and upstream profile conforms to equation $\frac{X^2}{11652^2} + \frac{Y^2}{6132^2} = 1$. The spillway is required to pass a design discharge of 8500 m^3/s (SPF 4715 m^3/s + GLOF 3715 m^3/s) with one gate inoperative and to pass check flood of 10615 m^3/s comprising of PMF (6900 m^3/s) + GLOF(3715 m^3/s) with all gates operational. A ski-jump bucket with 35 m radius, 36° lip angle and invert at El. 1694 m is provided for energy dissipation. A 15 m long concrete apron downstream of the ski-jump bucket has been provided.

Hydraulic model studies were conducted on 1:40 scale 2-D sectional model to assess the performance of spillway in respect of discharging capacity, general flow conditions and performance of ski jump bucket for the entire range of discharges. It was observed that the design discharge of 8500 m^3/s could be passed at RWL El. 1727.54 m and a discharge of 12000 m^3/s could be passed at FRL El. 1747 m with all gates fully open. With one span inoperative, a discharge of 9050 m^3/s could be passed at FRL. As such, the discharging capacity is found to be adequate. Water surface profile was observed along the centre line of spillway for the design discharge of 8500 m^3/s with all gates fully open. The trunnion axis of radial gates was well above the water surface profile. Hence the trunnion elevation at El. 1718 m is found to be acceptable. It was observed that the upper nappe of the incoming jet was not following the breast wall bottom profile for entire range of reservoir water levels with orifice flow. Therefore, it is necessary to modify the bottom profile of the breast wall so as to improve the effectiveness of entire height of orifice opening and for further improvement in the discharging capacity of spillway. Clear ski-action was observed for discharges up to 4250 m^3/s (50%) at FRL and for higher discharges submerged ski action was observed under gated operation. Ski action was not observed for any of the reservoir water levels up to FRL for ungated operation. In view of this, it is necessary to modify the design of the spillway and the ski-jump bucket to improve their performance. Further studies for the revised design have been taken up.

Flow conditions in the vicinity of the breast wall

Flow conditions over the spillway and energy dissipator

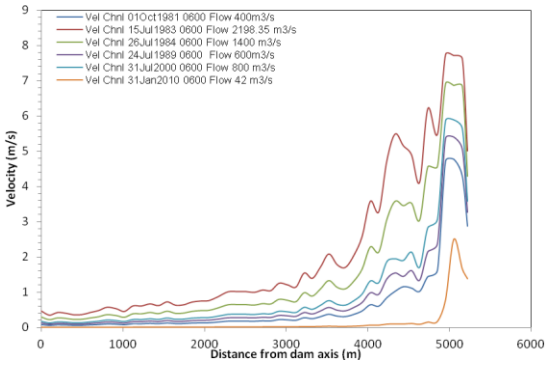
5153-MATHEMATICAL MODEL STUDIES FOR RESERVOIR SEDIMENTATION FOR ARUN-III HYDROELECTRIC PROJECT, NEPAL

The Satluj Jal Vidyut Nigam Ltd. (SJVNL) has proposed to implement Arun III Hydro Electric Project (900 MW), Nepal. The project is located on Arun River, a principal tributary of Sapt Koshi, near Num village of Sankhuwashabha District in Nepal. The project is planned as a run of the river scheme with 59 m high dam and the provision for annual flushing of reservoir through low level sluice spillways to remove deposited sediment.

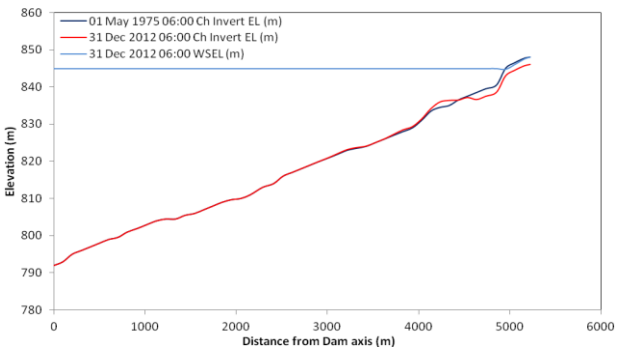
One dimensional mathematical model HEC-RAS 4.1 was used to estimate the sedimentation profile and assess the extent of sediment deposition in the reservoir for the reach of river Arun from about 5 km upstream to dam axis m. The daily suspended sediment concentrations data at Uwagaon (600 m upstream of dam site) from March 1989 to November 1989 were used for developing sediment rating curve. The simulation studies were carried out with observed daily flow series for the period from January 2009 to May 2013 by maintaining the downstream water level at dam axis at the FRL (El.845 m) and MDDL (El. 835 m). Changes in bed level, cross section and velocity profile were computed at the end of simulation period. Sediment deposition in the form of deltaic pattern was observed at upstream reach of reservoir. The maximum flow velocity near dam and at intake area was of the order of 0.3 m/s.

Long term simulation studies were also carried out for the period from May 1975 to May 2013 using the daily flow series. The advancement of delta deposition towards dam was observed to be at very low rate when reservoir was operated at MDDL and FRL.

Very low velocities were observed near the dam and at intake area and in the entire reservoir stretch during low flows. The velocity near dam and at intake area during lean flow season is insignificant and of the order of 0.02 m/s for reservoir operating at MDDL. The velocity during the observed maximum flow of 2198.35 m^3/s of 38 years was less than 1.0 m/s along considerable length of the reservoir. For the average annual peak flow of 1370 m^3/s, the velocity of less than 0.3 m/s was observed for reservoir length of about 0.6 km. Due to the prevailing low velocities, the reservoir was observed to function as a desilting basin.



Longitudinal velocity profile with reservoir at operating at FRL



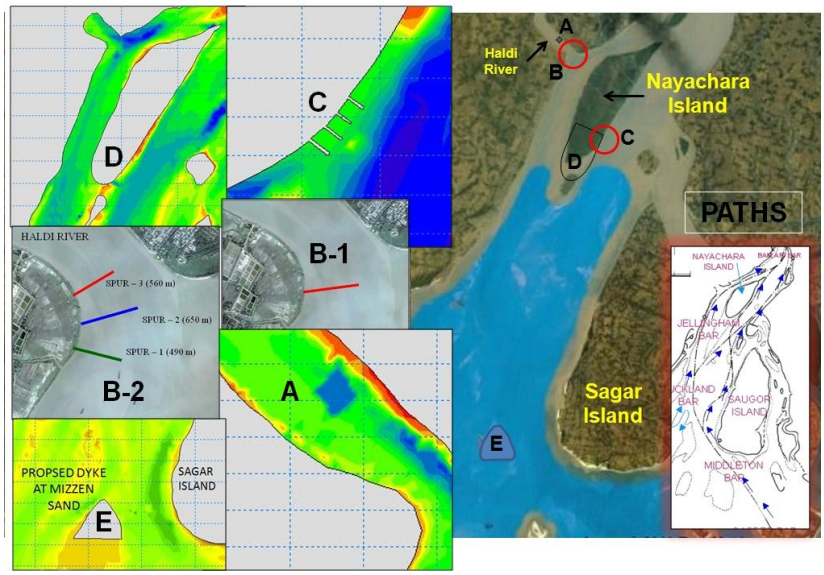
Longitudinal bed profile with reservoir operating at FRL

COASTAL & OFFSHORE ENGINEERING

5058-MATHEMATICAL MODEL STUDIES FOR VARIOUS FLOW-TRAINING MEASURES TO IMPROVE THE NAVIGATION CHANNEL LEADING TO HALDIA DOCK IN HUGLI ESTUARY, WEST BENGAL

The Kolkata Port Trust (KoPT) has two dock systems for the port operations i.e. Kolkata Dock System (KDS) and Haldia Dock Complex (HDC) located at Kolkata and Haldia respectively. The navigation channel route has to negotiate shallow bars, junctions and flow diversions due to heavy sediment depositions in Hugli Estuary. The channel passes through Middleton Bar, Auckland Bar, Jellingham and Ballari Bar. Due to major and frequent morphological changes, it is becoming increasingly difficult to maintain the channel even to a depth of (-)4 m below chart datum despite intensive dredging. In general, reduced flow in Haldia and Jellingham and the growth of Balari Bar are considered to have largely contributed to the deterioration in navigation depths in the Jellingham channel. Sediment in this region is in fluid mud state and simply slides in the relatively deeper channel under the influence of weak cross currents.

Hence, mathematical model studies were referred by KoPT to find the feasibility of cross dykes, spurs and reclamations across the estuary to increase the navigation channel depths and reduce the maintenance dredging. Five proposals of longitudinal dyke on southern part of Nayachara Island; silt trap in Haldi River; spurs in Haldi River mouth; spurs at south of Nayachara Island and dyke around Mizzen sand were tested. These proposals were examined in mathematical model using MIKE 21 flexible mesh software. Based on the model studies, the proposals of silt trap in the Haldi River and dyke in the southern part of Nayachara Island for land based disposal of dredged material were recommended as useful in improving navigation channel depths. These measures are expected to improve the depths on the Jellingham and Auckland Bars by 0.2 to 0.5 m.



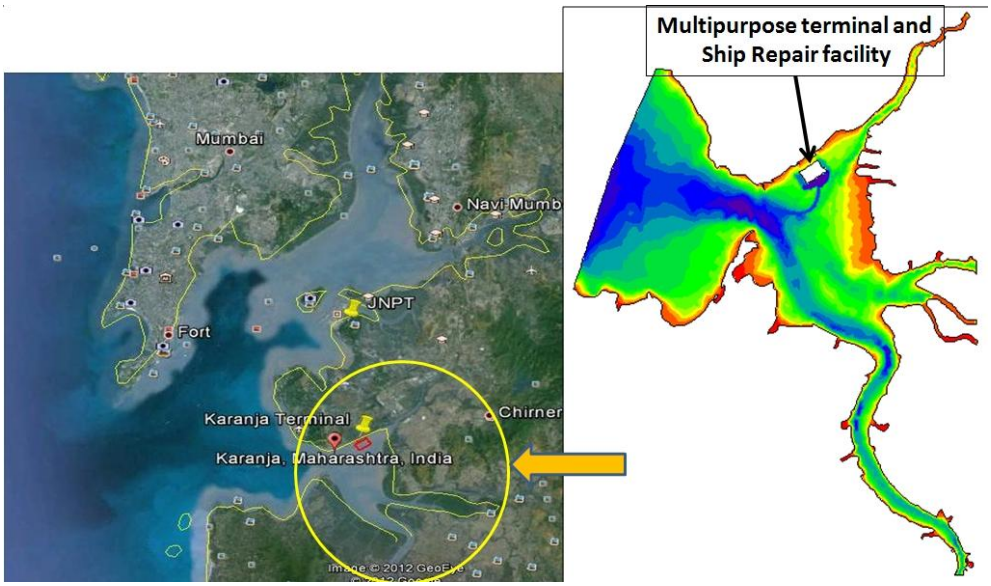
1) A : Silt Trap at Haldi River
2) B1: Single Spur at Mouth of Haldi River
3) B2: Group of Three Spurs at Mouth of Haldi River
4) C: Group of Four Spurs at South Nayachara Island
5) D: Dyke at South to Nayachara Island
6) E: Mizzen Sand Reclamation

Various flow training measures to improve navigation channel leading to Haldia Dock in Hugli Estuary

5059-MATHEMATICAL MODEL STUDIES FOR HYDRODYNAMICS, SILTATION / MORPHOLOGICAL CHANGES AND DISPERSION DURING DREDGING AND DISPOSAL FOR PROPOSED DEVELOPMENT OF MULTIPURPOSE TERMINAL AT KARANJA CREEK, NAVI MUMBAI

Karanja Infrastructure Private Limited (KIPL) engaged in the development of maritime & logistics infrastructure propose to develop a 'Multipurpose Terminal and Ship Repair Facility' along the Karanja Creek water front under the banner of 'Karanja Terminal and Logistics Pvt. Ltd'. The proposal as well as for coastal movements includes general cargo jetties to handle feeder traffic to MBPT / JNPT, a ship repair facility KIPL has approached WAPCOS to conduct a numerical model study and a suitable yacht / boat parking facility. About 80 hectares of inter tidal zone will be reclaimed for the project. The numerical model study were carried out by CWPRS on behalf of WAPCOS using MIKE-21 flexible mesh software for the hydrodynamics and morphological aspects including dredging and disposal.

The model simulations were done for the existing conditions as well as for the proposed development having large reclamation area falling in intertidal zone. Simulations indicated minor changes in hydrodynamic patterns near headland of Rewas area. Weak currents are predicted in basin area proposed for the berths which is due to the increase in the depth by dredging. It was concluded that the flow around the berth would not be much affected during major part of the tidal cycle except at high water conditions and the development would not have any major impact on the surrounding morphology. The location of dumping ground for dredged material was also decided using the model studies.



Developments in Karanja Creek, Raigarh

5065-5066-5067-HYDRAULIC MODEL STUDIES FOR THE DEVELOPMENT OF PROPOSED WESTERN DOCK AT PARADIP PORT, ODISHA

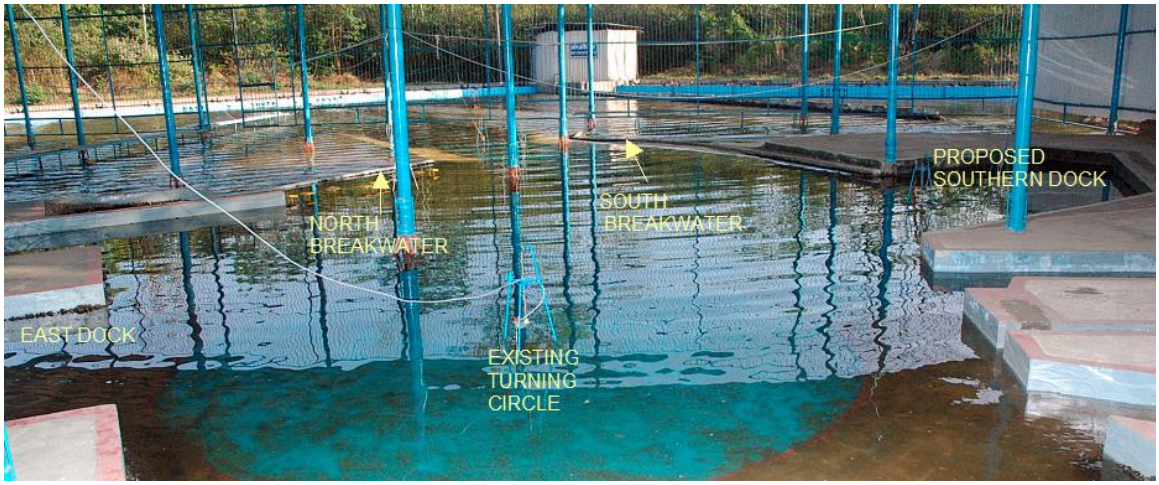
Paradip Port, which is one of the major ports of India, is situated on the East Coast of Odisha. Presently the Port handles vessels up to 80,000 DWT for the bulk cargo. The port proposes to expand its handling capacity for the traffic volume of next twenty years. In the first phase of expansion, the entrance channel would be deepened to -17.1m and approach channel to -19.6m to cater for 1,25,000 DWT vessels. Furthermore, a new southern dock and a western dock would be developed to cater for the bigger size ships. Studies are already carried out for the southern dock by CWPRS. Now Paradip Port Trust has referred the hydraulic model studies for the development of Western Dock. Three orientations of the western dock have been suggested by the Consultants, M/s Aurecon Australia-International Projects Pvt. Ltd. Hydraulic mode studies were carried out to select the best orientation of the western dock out of these three orientations.

Wave Tranquility studies were carried out on the existing physical model with a scale of 1:125 (GS) having facility to reproduce waves from the two predominant directions of East-South-East and South, which represent waves during North-East and South-West monsoons respectively. The studies revealed that, the wave disturbance in the proposed western dock for all the three alternatives / orientations is negligible. These wave heights are in the range of 0.1m to 0.2m form East-South-East and South direction, which are well within the permissible limit of 0.8 -1.0 m, for the bulk cargo vessels.

Mathematical model studies were also carried out to examine wave tranquility in the harbour in order to finalize Western Dock layout. The mathematical model studies also completment the above studies indicated that wave heights in the harbour will remain within the permissible tranquility limit of 1.0 m for the entire year for all the three layouts.

Mathematical model studies were also carried out to study the tidal hydrodynamics and estimation of likely siltation in the Western Dock; for the proposed three layouts. With the proposed Western Dock, the siltation in the harbour area would be about 0.46 Million M^3, 0.43 Million M^3 and 0.45 Million M^3 for the layouts 1, 2 & 3 respectively. Also, the maximum current strength in the proposed western dock area is only 4 cm/sec. As such, there is no significant adverse effect on the flow pattern as well as siltation in the harbour area for all the three alternative layouts of the western dock.

The hydraulic model studies indicate that for all the three alternatives of the Western Dock there is no significant impact on the wave tranquility, tidal currents and the siltation pattern due to above developments. However, considering the utility and the futher expansion of the port and also considering the fact that the existing turning circle can be utilized for ship maneuvering, layout-3 oriented along North-West and South-East, which can accommodate 6 capsize ships, is recommended for development of Western dock.



Waves simulated from east-south-east direction in the physical model of Paradip port

5069-WAVE FLUME STUDIES FOR RESTORATION OF THE DAMAGED BREAKWATER AT PARADIP PORT, ODISHA

Paradip port is one of the major ports located on the east coast of India. It is a lagoon type, deep draft inner harbour Port in the country. The harbour is protected by two breakwaters – South and North breakwaters on either side of the approach channel. The South breakwater was constructed between 1964 and 1966 with 8 t to 10 t stones in the armour. The breakwater was extended from time to time to provide protection for the ships at the entrance. Recently, it was extended by about 100 m (3rd phase extension) in April 2012. During the monsoon season, in the month of June 2012, some portion in 3rd phase extension, especially the roundhead got damaged due to rough sea conditions. Paradip Port Trust (PPT) requested CWPRS to provide suitable permanent solution for restoration of the damaged south breakwater. It was observed that the breakwater extension was carried out with 8 t to 10 t stones in the armour, without any toe-berm with the armour placed on a steeper slope.

Based upon the wave flume studies conducted to design the cross-sections for the restoration of south breakwater, solution was evolved in which the existing roundhead was accommodated in the core of the breakwater and appropriate toe-berm was also considered. The proposed cross-section for trunk and roundhead consists of 8 t – 10 t stones on 1:2.5 slope in the armour. This section is stable under the design wave height of the order of 5 m for zero order damage (i.e. less than 1%) & first order damage (i.e. 1% to 5%) for the wave height up to 7.0 m. The lee side slope of the trunk section is kept steep at 1:1.5 to accommodate the section in the available width between the edge of the channel and base of the existing south breakwater.

Damaged roundhead of southern breakwater

5071-72-73-74 -HYDRAULIC MODEL STUDIES FOR THE DEVELOPMENT OF FISH BOAT LANDING FACILITIES AT UVARI VILLAGE NEAR KUDANKULAM, TAMILNADU

Uvari village is situated about 20 km north of Kudankulam on the southern coast of Tamilnadu. As a part of the programme for the development of neighbourhood around the Kudankulam Nuclear Power Plant (KKNPP), the state government of Tamil Nadu and KKNPP have a proposal to provide coastal protection measures as well as fish boat landing facilities at Uvari village. The hydraulic model studies were carried out at CWPRS to evolve the harbour layout, to predict the shoreline changes and to design the breakwater cross-sections.

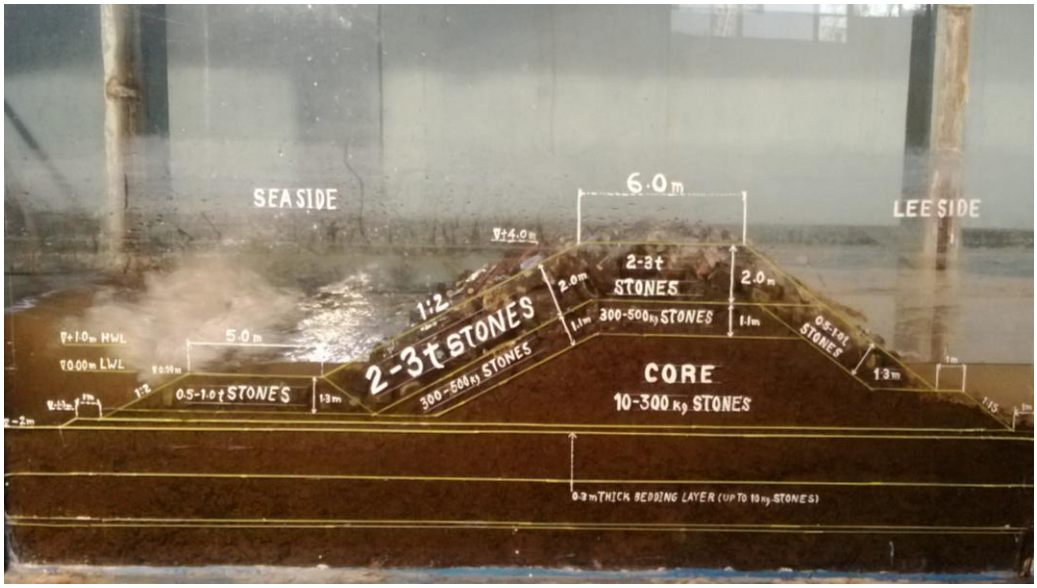
Mathematical model studies for harbour layout were carried out in two stages i.e. wave transformation and wave tranquility. The conceptual layout consists of two shore connected breakwaters, a 1275 m long south breakwater and 400 m long north breakwater. A 200 m wide opening has been provided towards the north east direction. Wave propagation studies with MIKE-21 SW model indicated that the predominant directions of the waves are from east to SSW sector with the wave heights are varying between 1.5 m to 3.5 m. Wave tranquility in the fish boat landing area was simulated using the MIKE-21 BW model. The studies showed that the proposed layout provides the desired wave tranquility of 0.3 m for safe landing of the fish boats in the harbour for about 355 days in a year.

Studies for assessing the shoreline changes were carried out using Remote Sensing Technique. Digital Remote Sensing satellite data covering a coast of about 10 km north and south of the Uvari village for the period from 1998 to 2011 were utilized for the studies. There was no noticeable change in the shoreline along the coast in the vicinity of Uvari, on a synoptic scale. The shoreline has neither receded nor advanced; however, some minor shoreline changes have been noticed, from the year 2004 onwards.

The shoreline changes likely to occur due to construction of breakwaters in the vicinity of Uvari village were also predicted through mathematical model studies. LITPACK model was used to simulate the littoral drift and coastline evolution. Northward and southward drifts were found to be of the order of 0.5 million cum/year and 0.3 million cum/year, respectively. Net drift is towards north and is of the order of 0.2 million cum/year. Shoreline evolution was simulated for 5 years with the breakwaters and the studies indicated an average erosion of the order of 50 m towards north of northern breakwater, and accretion towards the south of southern breakwater. The extent of erosion would be about 2 km towards north of the northern breakwater. The area needs to be protected either by seawall or a series of groynes.

Desk and wave flume studies were also carried out for the design of cross-sections of the breakwaters. The conceptual cross-sections were evolved initially for various bed levels using the design breaking wave criterion. The armour weight was computed using Hudson's formula. The conceptual cross-sections of the breakwater were tested in a wave flume to check its hydraulic stability against the wave attack. A trunk section at – 3.5 m bed level consists of 4 t to 5 t stones in the armour layer on 1:2 slope. Whereas, the roundhead at -3.5 m depth consists of 4 t tetrapods in the armour. The sections worked out conceptually, were found stable under the design wave conditions and hence were recommended. The northern stretch of about 2 km length is likely to suffer erosion as such a rubblemound seawall with 100 to 200 kg stones in the armour is recommended to prevent erosion in the northern stretch of Uvari coast. The shore-line changes studies have indicated the littoral drift from both the directions i.e. northward as well as southward.

Since the northern breakwater is protruding in the sea only upto -2.0m contour, some of the sediments are likely to accumulate in the harbour area as well as at the mouth of the harbour. As such, it is essential to carry out periodic maintenance dredging of the harbour area and the entrance; to keep the harbour operative.

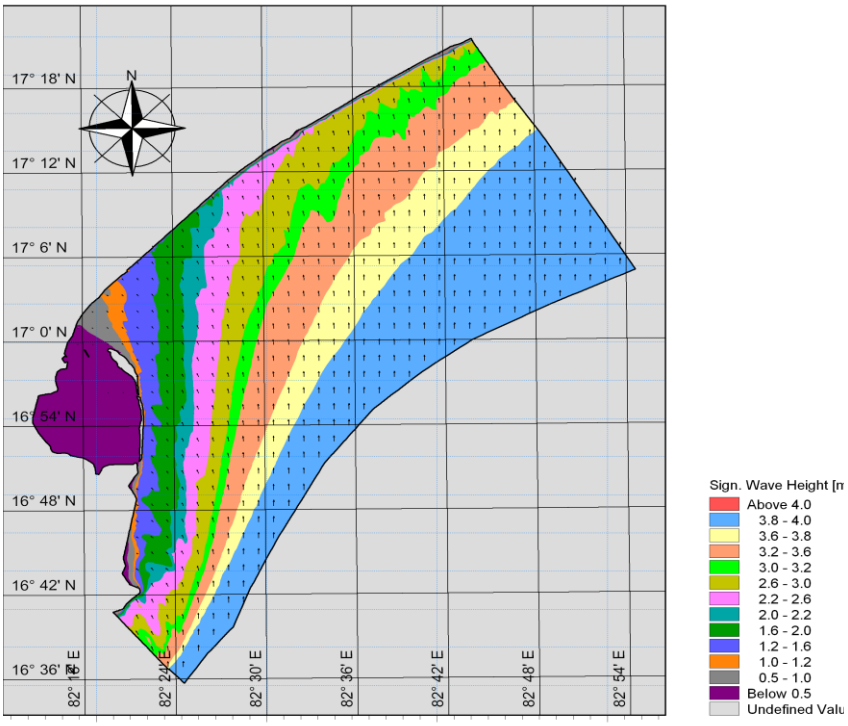


Wave flume studies for south breakwater (Hb = 2.10m)

5075-HYDRODYNAMIC STUDIES TO ASSESS THE IMPACT OF THE PROPOSED DEVELOPMENT OF FLOATING STORAGE RE-GASIFICATION UNIT AT KAKINADA DEEP WATER PORT

Andhra Pradesh Gas Distribution Corporation Limited (APGDC) is developing LNG Floating Storage and Regasification Unit (FSRU) Project at Kakinada Deep Water Port. The proposed facility comprises of Jetty, FSRU, Subsea pipeline, Onshore Receipt Facility and connectivity to the existing Gas grid. The facility is proposed to be developed on the leeside of the existing breakwater, which will provide tranquil conditions for round the year operation of the facility. In order to examine the technical feasibility of the proposed FSRU project, mathematical model studies for wave propagation were carried out to investigate the wave conditions along the approach channel and near the coastline adjacent to the project site and Uppada coastline.

For simulation of wave propagation from offshore to nearshore region, mathematical model MIKE21-SW was used. The wave propagation studies showed that the predominant directions of wave approach are from East, ESE, SE, and SSE. No significant change in the wave climate in the vicinity of Port area was observed due to deepening and widening of the channel. The proposed development of FSRU project is within the Harbour (Protected) area at Kakinada and will not have any significant effect on the adjacent coastline at Uppada. The present erosion at Uppada coastline is mainly due to starvation of the beach and the severe wave attack during the monsoon.

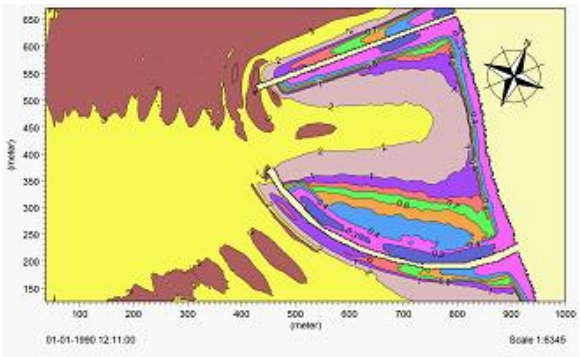


Wave height distribution for proposed layout for waves incident from south direction

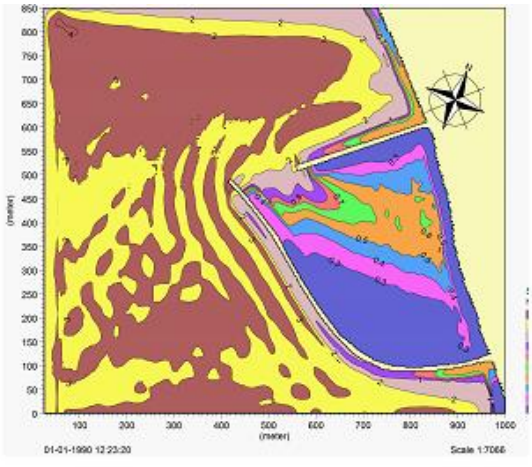
5076-MATHEMATICAL MODEL STUDIES FOR ASSESSMENT OF WAVE TRANQUILITY AND SHORELINE CHANGES FOR THE PROPOSED DEVELOPMENT OF MINI FISHING HARBOUR AT VARKALA CHILAKKOOR, KERALA

The Harbour Engineering Department, Kerala have a proposal for development of a mini fishing harbour at Varkala Chilakkoor, Kerala . Mathematical model studies for assessment of wave tranquility in the harbour and prediction of shoreline changes due to construction of the breakwaters were carried out at CWPRS to evolve a suitable harbour layout. Studies for transformation of deep water wave conditions to near shore location indicated that in the nearshore region of Varkala, in 15m depth, the predominant wave directions are from SSW, SW, WSW and West. The proposed harbour layout consists of 545m long southern breakwater and 400m long northern breakwater with a gap of 180m between them for the entrance of the ships. Studies for simulation of wave propagation in the harbour, using MIKE 21-BW model indicated that with the proposed harbour layout, area in front of the harbour entrance is exposed to waves of the order of 2.0m to 2.5m for incident waves of 3m to 3.5m.

In order to improve tranquil conditions in the harbour, CWPRS modified the layout with 742 m long southern breakwater and 292m long northern breakwater. The width of the entrance channel was reduced to 125m. With modified harbour layout , it was observed that the wave tranquil conditions in the harbour have improved to a greater extent with the wave heights near the landing area in the harbour remaining below the permissible wave height of 0.3m for about 300 days in a year. Mathematical model studies for estimation of shoreline changes indicated advancement of about 35m, 70 m, 95 m and 115m south of southern breakwater in 1, 5, 10 and 15 years respectively. Shoreline will erode by about 5 m, 15 m and 30 m north of northern breakwater in 5, 10 and 15 years respectively, and needs to be protected by suitable coastal protection works.



Proposed harbour layout (by project authorities)



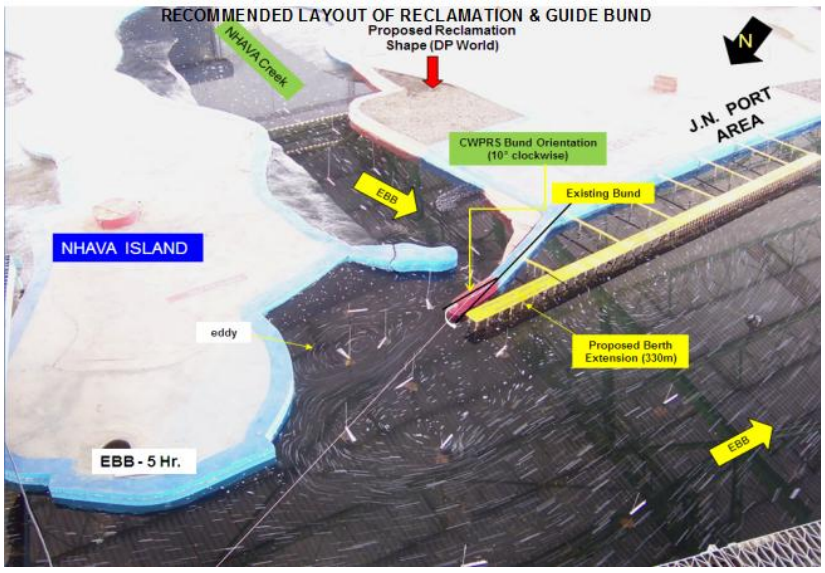
CWPRS recommended harbour layout

5080-HYDRAULIC MODEL STUDIES FOR GUIDE BUND AND RECLAMATION IN NHAVA CREEK FOR M/s DP WORLD AT JAWAHARLAL NEHRU PORT, MUMBAI

The Jawaharlal Nehru Port, one of the major ports of India located on the West coast in Thane Creek, has awarded a work of development of 330 m long container berth to M/s Dubai Port (DP) World, a multinational terminal operating company; on BOT basis. The DP World proposed to modify the shape of the reclamation and the orientation of guide bund earlier recommended by CWPRS based on the model studies carried out in the year 2004. In order to evaluate the effect of the above changes on flow conditions at Nhava creek entrance, studies were referred to CWPRS by DP World through M/S Water & Power Consulting Services (WAPCOS), Pune. Model studies were carried out on the existing physical model of Mumbai port [1:400(H) ; 1:80(V)] for prevailing hydrodynamic conditions with modified shape of reclamation alongwith 160 m long bund at 10^0 and 18^0 clockwise orientations.

Model studies indicated that with the modified shape of reclamation and guide bund at an orientation of 10° clockwise w.r.t. the axis of the existing bund, there is no significant change in flow pattern at the entrance of Nhava creek, and this will not have any adverse impact on the existing berthing facilities of ONGC located north of proposed container berth. The observed maximum values of current at Nhava creek entrance are about 1.8 m/s and 1.5 m/s during flood and ebb flow respectively. During flood, flow is parallel to the proposed berth; while during ebb flow, eddies are formed at the berth. However, these eddies will not affect the ships at the proposed berth.

The hydraulic model studies were also carried out to study the effect of modified shape of reclamation with 160 m long guide bund at an angle of 18° clockwise w.r.t. the axis of the existing bund. The model studies indicated that there is an overall increase in strength of current with maximum current of 2.3 m/sec during flood tide and about 1.8 m/sec during ebb tide. Also there are formations of large eddies at northern end of proposed 330 m long berth as well as in front of the berthing facilities of ONGC. Hence proposed bund oriented at 18^0 may cause hindrance problem to ships. Hence, modified shape of reclamation with 160m long guide bund at 10^0 clockwise orientation w.r.t the existing bund is recommended. Further, in order to have a smooth movement of container carrying trucks, it is recommended to provide a piled approach, connecting the proposed berth and the guide bund so that, it may not alter the flow pattern at Nhava creek entrance.

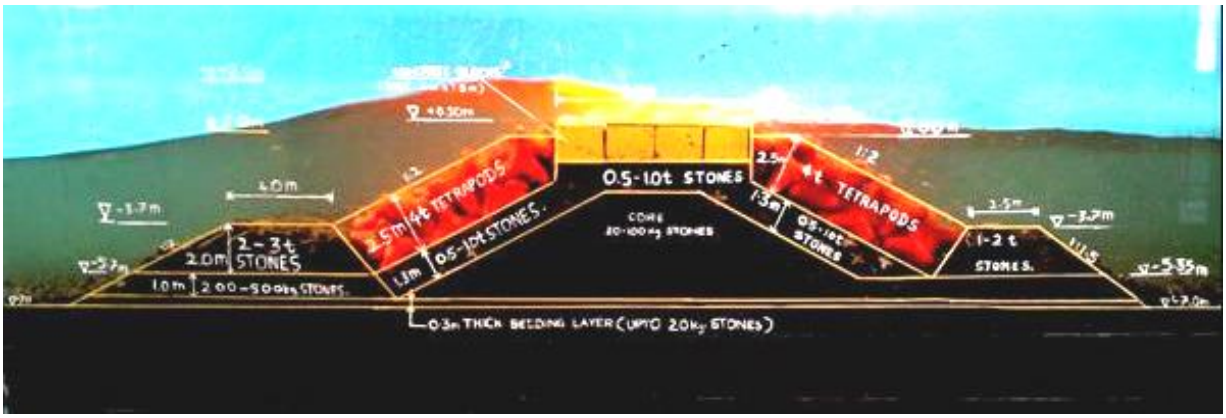


5090-DESK AND WAVE FLUME STUDIES FOR THE DESIGN OF CROSS-SECTIONS FOR OFFSHORE REEFS FOR SUSTAINABLE COASTAL PROTECTION AT ULLAL, MANGALORE, KARNATAKA

Ministry of Water Resources, Government of India, sought the assistance of Asian Development Bank (ADB) to support their National Coastal Protection Programme. As a corollary to the above, ADB initiated the Project Preparation Technical Assistance (PPTA). The coastal protection for the erosion at Ullal, Mangalore in Karnataka was taken up for detail study as a sub-project by the ADB Consultants. An integrated development plan prepared by the ADB Consultants for sustainable coastal protection includes construction of two offshore reefs & four inshore berms to trap the sediments, nourishment of the Ullal beach and Re-habilitation of breakwaters to facilitate increase in sand movement towards south.

The design of cross-sections of two delta shaped offshore reefs as low-crested rubblemound structures proposed by the consultants as part of sustainable coastal protection at Ullal was referred to CWPRS by the Government of Karnataka. Three alternative cross-sections of offshore reefs at the bed level of -7.0 m have been evolved based on the desk and wave flume studies. Alternative-I consists of 4 t tetrapods in the armour placed on 1:2 slope with concrete cubes on the crest while alternative-II consists of 4 t tetrapods in the armour placed on 1:2 slope with 6 to 8 t stones on the crest and Alternative-III consists of 6 to 8 t stones in the armour placed on 1:2 slope as well as on the crest. The roundhead portions of different alternatives at - 7 m bed level have also been evolved.

The hydraulic stability tests were conducted in the wave flume by reproducing the sections to a Geometrically Similar (GS) model scale of 1:30. The sections were recommended as they are found stable upto the breaking wave height of 5 m. Based on settlement analysis for the foundation strata, initial settlement of 1 m was suggested for estimation of quantities for the offshore reefs.



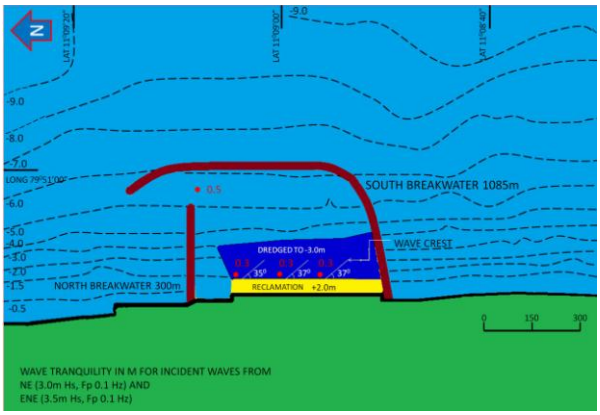
Wave flume studies for the design of offshore reef at Ullal

5099-WAVE TRANQULITY STUDIES FOR DEVELOPMENT OF FISHING HARBOUR AT POOMPUHAR, TAMILNADU

A fishing harbour is proposed at Poompuhar, on the east coast of India in Tamilnadu state, for catering to fishing crafts of size 15 - 20 m length requiring a draft of about (-) 3.0m below chart datum. The coastline at the site of proposed harbour is exposed to waves and littoral drift processes. Predominant directions of wave approaching the site are from north-east to south-east sector with significant wave heights between 0.5m to 3.5m. The coastline, which is aligned almost in north-south direction with an inclination of 359^0 N, is sensitively balanced and has comparable sediment drift both from north and south sides with nodal drift regime. Based on site inspection the annual net drift was assessed to be from south to north direction and therefore a suitable northerly entrance was considered in the harbour layout to block bypassing of the sand. The permissible limit of wave tranquility at the wharf has been considered as 0.3m.

The original layout as proposed by the Project authorities consisted of a south breakwater of 910m length at -5.0m depth and north breakwater of 255m length extended upto -4.0m depth. The studies at CWPRS indicated that this layout would not be able to provide required wave tranquillity and would not be adequate to block the bypassing of the littoral drift into the basin. Based on the preliminary mathematical model studies conducted for the dominant incident waves, modifications to the layout were suggested with 1100m length of south breakwater extending upto -6.5m depth and north breakwater of 390m length up to -5.5m contour. A loss of about 40 operational days in a year was assessed due to exceeding of the permissible tranquillity limit of 0.3m.

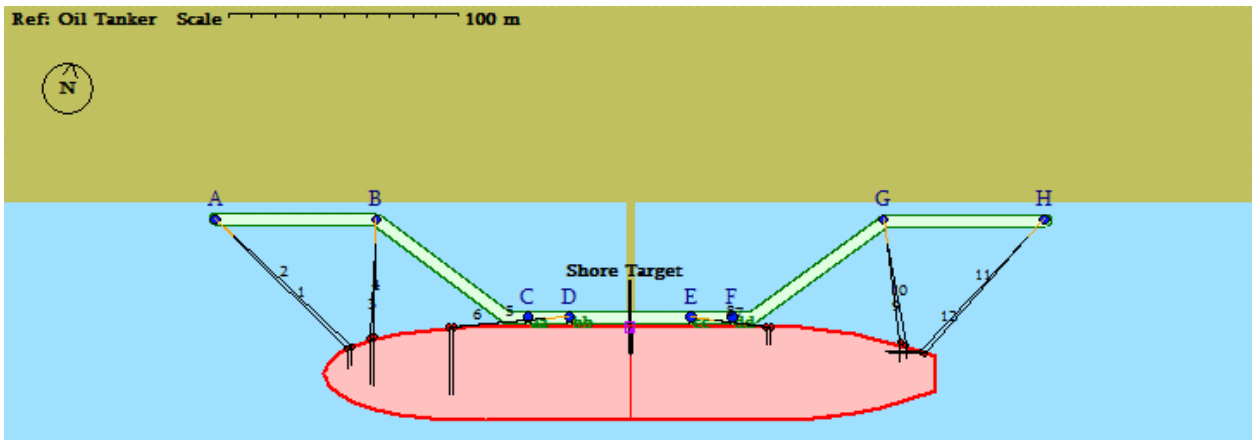
To further optimize the layout as evolved using mathematical model studies, detailed physical wave model studies were conducted for the significant incident waves (H_s) and period (f_p) from the most critical northeast (H_s - 3.0m and f_p - 0.1/Hr) and east of northeast (H_S - 3.5m and f_p - 0.1/Hr) directions. Alternative layouts were simulated in the physical model for the northerly entrance using random sea wave generation facility at geometric similar scale of 1/120. After a number of trials, an optimum layout was evolved which consisted of a south breakwater of length 1085m upto a depth of -5.5m and a north breakwater of 300m length extended upto a depth of -5.0m. The final layout using physical wave model provided the specified wave tranquillity of 0.3 m throughout the year. A reduction of 15m length in the south breakwater and 90m reduction in the north breakwater could be also achieved. The complex interaction of diffracted waves at the entrance could be well reproduced and visualized in the physical wave model and including suitable reproduction of the nonlinear geometry of the breakwater structures.



Optimized layout using physical model studies

5101-SHIP MOORING ANALYSIS FOR THE PROPOSED MULT JETTY AT COCHIN PORT, KERALA

Cochin Port has a proposal to develop a jetty for Oil Tankers and LPG Vessels at Vypin near the entrance to Cochin Port. In this regard mathematical model studies for the prediction of moored ship motions, rope tensions, fender compressions, and design of mooring arrangement at the proposed MULT jetty were carried out at CWPRS. The software OPTIMOOR developed by M/s Tension Technology International, UK has been used for the prediction of ship motions, rope tensions, bollard pull and fender compression. The moored ship motions at the berth were simulated taking into account the geometry of the ship, its inertial characteristics, added mass, other hydrodynamic characteristics, and environmental loads due to wave, wind and current. The elastic characteristics of mooring ropes and fenders were also considered in the studies. Two Oil Tankers of 80,000 DWT and 10,000 DWT, and two LPG Vessels of 55,000DWT and 5,400 DWT were used for simulation as part of the study. The Super Cone Fender of 2 m height was found suitable for the berthing of the biggest ship i.e., 80,000 DWT Oil Tanker. The 80,000 DWT Oil Tanker and 55,000 DWT LPG Vessel were moored with steel wire attached with nylon tail, whereas the smaller ships were moored with polypropylene rope. Waves of 1.1 m height and 8 s period, 16 knots winds, current speed of 0.5 m/s in flood and ebb, and tidal variation of 0.7 m were considered during simulation. The maximum motion amplitudes of moored ships in six degrees of freedom, loads in mooring lines and fender compressions were obtained and all these values are well within the safe operational limits as specified by PIANC for all the four types of vessels.

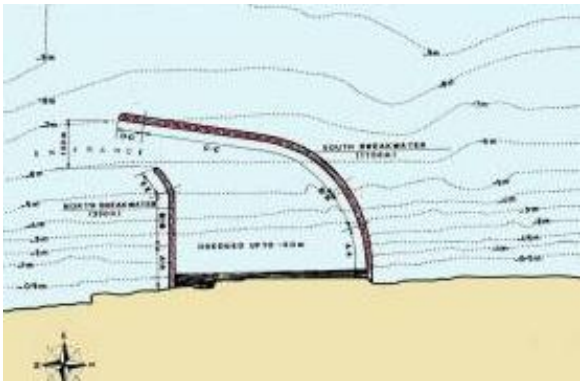


80000 DWT oil tanker moord to jetty

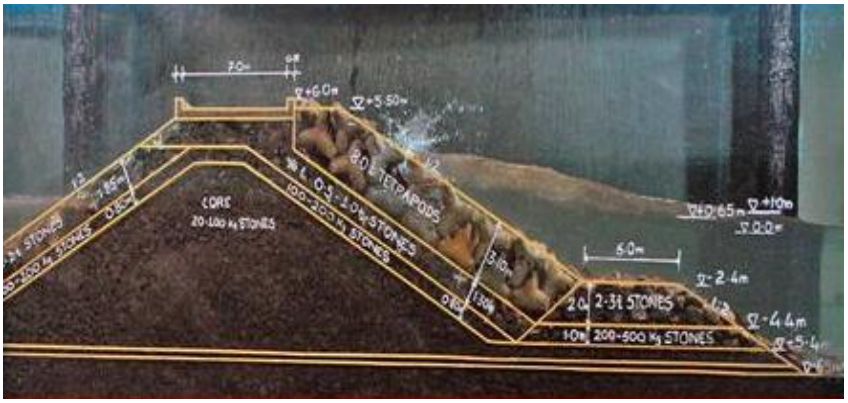
5103-DESIGN OF BREAKWATERS FOR THE DEVELOPMENT OF FISHERY HARBOUR AT POOMPUHAR, TAMILNADU

The Department of Fisheries, Government of Tamilnadu have a proposal for development of a fishing harbour at Poompuhar in Tamilnadu state. The Central Institute of Coastal Engineering for Fishery (CICEF), Bangalore has conducted feasibility studies for development of this fishing harbour. The wave tranquility studies have been carried out using physical and mathematical models at CWPRS. Two breakwaters are proposed, to achieve the required tranquility in the harbour and an optimum layout with northerly opening was suggested. The layout consists of 1100m long south breakwater extending up to (-) 6.5m contour and north breakwater of 390m length extending upto (-) 5.5m. Desk and wave flume studies have been carried out for evolving design cross-sections of the breakwaters at various bed levels. Based on the site specific data pertaining to bathymetry, wave condition and tidal levels, conceptual design of cross-sections were evolved using the empirical methods.

A design wave height of 4.0 m was considered for the deeper sections. The breakwaters section consists of 2 t tetrapods in the armour placed at 1:2 slope for the root of breakwater to (-) 2 m bed level, 4 t tetrapods in the armour for (-) 2 m to (-) 5 m bed level, 8 t tetrapods in the armour for (-) 5 m to (-) 6.5 m bed level, 10 t tetrapods in the armour for roundhead portion at (-) 7 m bed level for south breakwater and 8 t tetrapods in the armour for roundhead portion at (-) 5.5 m bed level for north breakwater. The hydraulic stability tests were conducted in the wave flume by reproducing the sections to a Geometrically Similar (GS) model scale of 1:32. The sections were recommended as they were found stable upto the breaking wave height of 4 m.



Fishing harbour layout

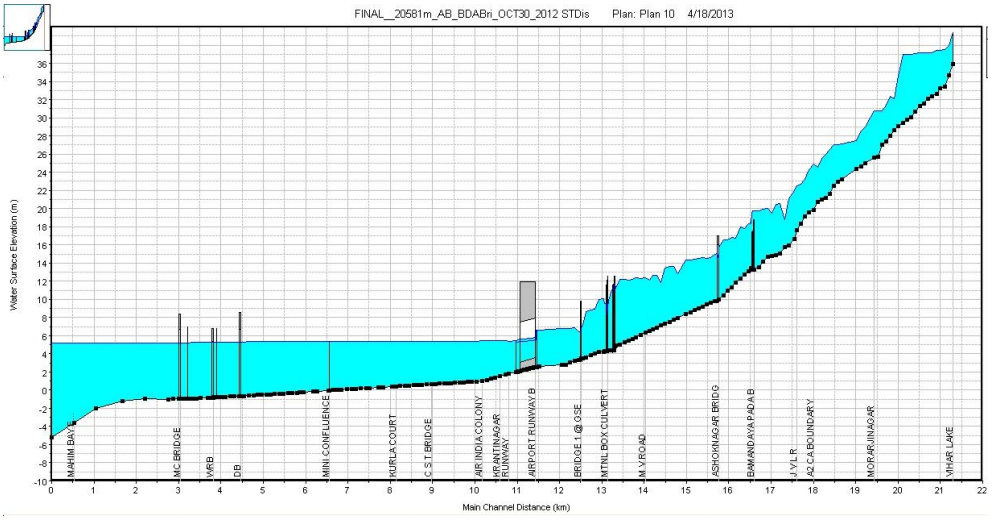


Wave flume-stability test of breakwater

5104 - MATHEMATICAL MODEL STUDIES FOR FLOOD DRAINAGE CAPACITY OF ADDITIONAL WATERWAY CHANNEL AND ROAD BRIDGE NO. 1 ON MITHI RIVER WITHIN CHATRAPATI SHIVAJI INTERNATIONAL AIRPORT (CSIA) AREA, SANTACRUZ (E), MUMBAI

After the unprecedented rainfall and floods in Mithi River, Mumbai on 26th July 2005 the Mithi River Development and Protection Authority (MRDPA) implemented the Mithi River channelization program recommended by Central Water and Power Research Station (CWPRS), Pune, through Municipal Corporation of Greater Mumbai (MCGM) and Mumbai Metropolitan Region Development Authority (MMRDA). A part of the Mumbai International Airport is constructed across the Mithi River by providing Box Culvert. The Mumbai International Airport Pvt. Ltd. (MIAL), Mumbai has proposals for improving the operational facilities in the area adjoining the Mithi river. MIAL has plans to construct two bridges viz. Road Bridge No.1 near Ground Service Equipment (GSE) area on Mithi River, upstream of MIAL area and another Additional Waterway Channel parallel to the existing Airport Runway Box Culvert for improving the conveyance in the Mithi river reach falling within the Airport area. The 1-D mathematical model studies for said bridge structures were conducted at CWPRS for estimation of flow conditions and water levels using the public domain software HEC-RAS, developed by U.S. Army Corps of Engineers, USA.

The bridge proposals were simulated in the model for rainfall event of 100 year return period having one-day maximum rainfall of 570 mm, obtained from analysis of latest Isopluvial Maps received from India Meteorological Department (IMD). The sea tide boundary at Bandra point in Mahim Bay specified as a stage hydrograph and peak ordinates of flood hydrographs computed using the Rational Method and CWC method were applied at the upstream boundary. The model simulations were done for steady state discharge conditions due to steep river gradient in upstream reach which otherwise would cause super critical flow conditions for unsteady discharge state. Model simulations indicated that rendering the model unstable for the 100 year return flood, water levels would be well within the deck levels of the box culverts and would not have adverse afflux conditions at the upstream and downstream of the bridge structures.



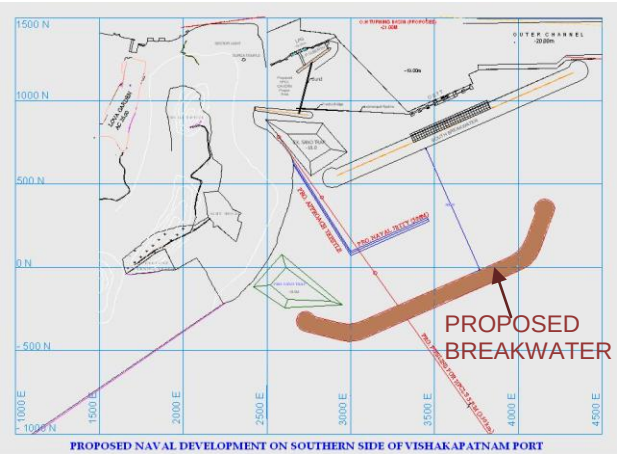
Longitudinal profile of maximum flood water levels in Mithi river

5107- DESIGN OF ROUNDHEADS OF BREAKWATER FOR DEVELOPMENT OF OUTER TO OUTER HARBOUR AT VISAKHAPATNAM

Visakhapatnam port is one of the major ports on the east coast of India which has been developed in phases. The existing outer harbour consists of various berths/terminals and jetties protected by the North breakwater (412 m), South breakwater(1543 m) and East breakwater(1069 m). The Commander, Command Plans Officer (AOL), Eastern Naval Command, Visakhapatnam, referred various hydraulic model studies through Visakhapatnam Port Trust (VPT) in connection with the proposed development of berths for Navy in Outer to Outer harbour expansion project at Visakhapatnam Port.The proposed development consists of construction of 1725 m long additional breakwater at south of the existing south breakwater and a 500 m long berths for Navy in outer to outer harbour expansion.

The suitability of conceptual layout plan of the outer to outer harbour proposed by VPT was confirmed by mathematical model studies carried out at CWPRS. Desk and wave flume studies have been conducted for evolving design cross-sections of the roundhead of breakwater at -18.0 m bed level. Based on the site specific data regarding bathymetry, wave condition and tidal levels, conceptual design of cross-sections were evolved using the empirical methods.

A design wave height of 7.6 m (H_s/non-breaking) was considered for the studies. Two roundhead cross-sections with 30 t tetrapods in the armour placed at 1:2 slope at -10.0 m & -18.0 m depth were suggested. The hydraulic stability tests were conducted in the diffraction basin of 75 m long regular wave flume by reproducing the sections to a Geometrically Similar (GS) model scale of 1:55. Two trunk cross-sections with 30 t tetrapods in the armour at -12 m & -18 m bed level were also suggested. The roundhead cross-section was found stable upto the non-breaking wave height of 7.6 m and hence was recommended for construction.



Layout of proposed breakwater

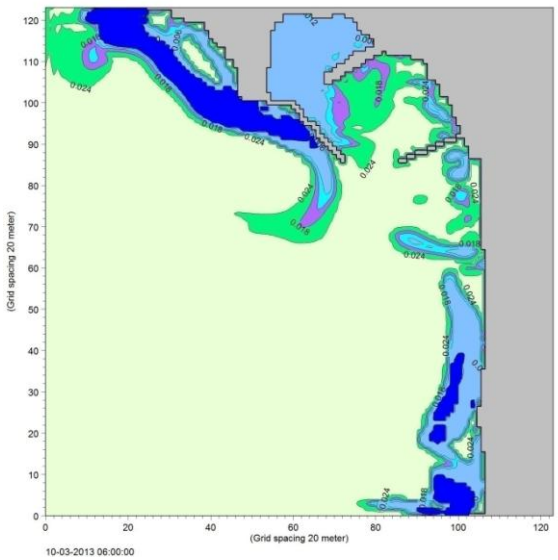
Wave flume testing of roundhead of breakwater

5116-MATHEMATICAL MODEL STUDIES FOR DEVELOPMENT OF FISHERIES HARBOUR AT MOPLA BAY, KERALA

Mopla Bay is situated about 3.0 km south of Kannur on Kerala coast at longitude 75^0 22′ E and latitude 11^0 51′ 40″N. In the year 1960, it was proposed to develop a fishing harbor under Norwegian funds and by the year 1969, a breakwater of length 240 m was completed but due to heavy siltation inside the harbor basin, the construction was stopped by the authority. Later on, physical wave model study was carried out by Kerala Engineering Research Institute (KERI), Peechi, who recommended two breakwaters; main breakwater and lee breakwater along with a sand trap. Based on this the existing main breakwater (south) was extended by 60 m and lee breakwater (north) of 500 m length was constructed in May 1999, but no dredging was carried out at that time.

The Chief Engineer, Harbour Engineering Division of Kannur district referred model studies to CWPRS to simulate tidal hydrodynamics and siltation and evolve a suitable layout with minimum sedimentation in the Molpa Bay basin using mathematical model. Accordingly, the studies were carried out to simulate tidal hydrodynamics and sedimentation pattern using MIKE 21 software for five layouts proposed by the project authorities and to arrive at the best suited layout in the present scenario by optimizing its dimension and orientation.

In the optimized layout, the total breakwater length is 500 m and sedimentation in the harbour reduces to 1/6th (i.e. 0.034 m) of the existing sedimentation in dredged condition. The sedimentation in the optimized layout is relatively more than the sedimentation in Layout-I but the breakwater length in the optimized layout is reduced by 620 m in comparison to that of Layout-I. Hence, it can be concluded that the optimized layout with extension of main breakwater by 200m and an additional breakwater of 300m may be suitable for the proposed fisheries harbor. It is also observed that the siltation rate in the existing harbour is of the order of 0.1 m per annum in the un-dredged condition and 0.2 m per annum in the dredged condition. Based on this, it is suggested that regular dredging would be required to maintain the operational depth inside the harbour area even though provision of the breakwaters would be able to reduce the siltation upto 0.034 m per annum inside the harbour basin.

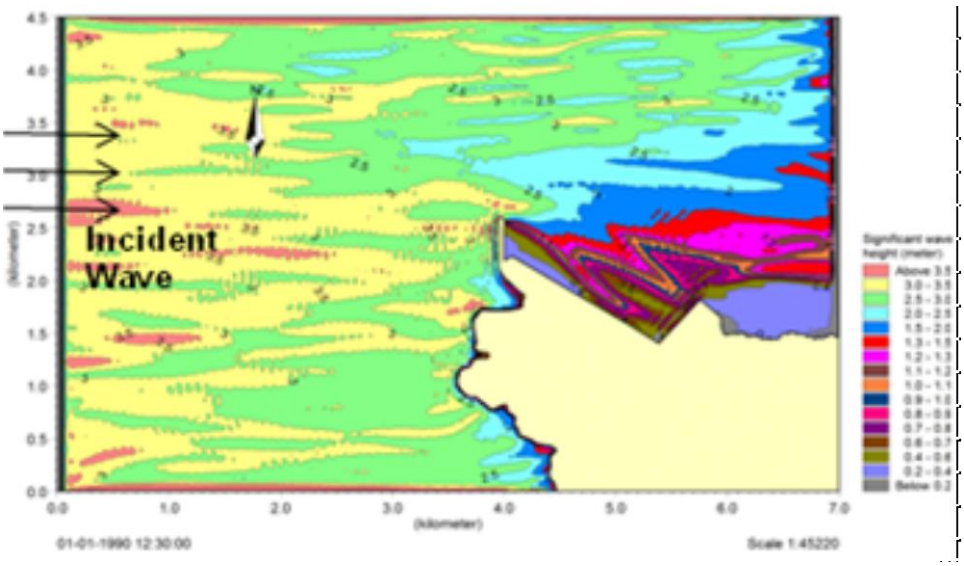


Siltation pattern after one month simulation under proposed optimized layout

5117-MATHEMATICAL MODEL STUDIES FOR IMPROVING WAVE TRANQUILITY IN JSW PORT AT JAIGARH, MAHARASHTRA

M/s JSW Infrastructure Logistic Limited (JSWIL) have developed an All Weather Green Field Port at Jaigarh, Maharashtra, on the west coast of India, situated at latitude 17^0 18′ N and longitude 73^0 12′ E. The development Phase-I, consists of two bulk berths and an approach channel and turning circle dredged to -14.3m with respect to chart datum. The port has a 510 m long breakwater projecting from the Jaigarh Head to give protection from extreme weather conditions in South West monsoon. The site is mostly affected by the Westerly and North westerly waves during South West monsoon, causing severe movements of moored ships at the berths, which badly affect loading-unloading operations at the berth. In this regard mathematical model studies were referred to CWPRS through M/s WAPCOS, to improve wave tranquility in the harbour and to provide adequate tranquil conditions for port operations during South West monsoon.

Wave tranquillity studies with MIKE21- BW model indicated that wave heights are more than the permissible wave height of 0.8m for the existing breakwater as well as for breakwater extension of 150m and 200m. Wave heights in the Berth area would be more than the permissible limit of 0.8 m during SW monsoon season for about 15 to 20 days for the existing layout and about 5 to 7 days for breakwater extension of 150m. Tranquillity near the berths would improve further with extension of the existing breakwater by 300m. However, the waves are seen to be approaching the berth at beam and also with severe wind at beam. Therefore ship motion studies of moored ships are necessary to ensure safe operations at the berths during SW monsoon.



Wave height distribution in the harbour

5118-MATHEMATICAL MODEL STUDIES FOR DEVELOPMENT OF FISHING HARBOUR AT POOMPUHAR, TAMILNADU

The department of Fisheries, Government of Tamilnadu have a proposal for development of a fishing harbour at Poompuhar in Tamilnadu state. The harbor layout proposed by CICEF consists of a south breakwater of 910m length and north breakwater of 255m length. In this regard Chief Engineer, department of Fisheries, Tamilnadu referred model studies to CWPRS to suggest a suitable layout of the breakwaters to minimize siltation in the harbour and also to achieve the desired wave tranquillity in the harbour. Accordingly, mathematical model studies were carried out at CWPRS to optimize the layout of the harbour.

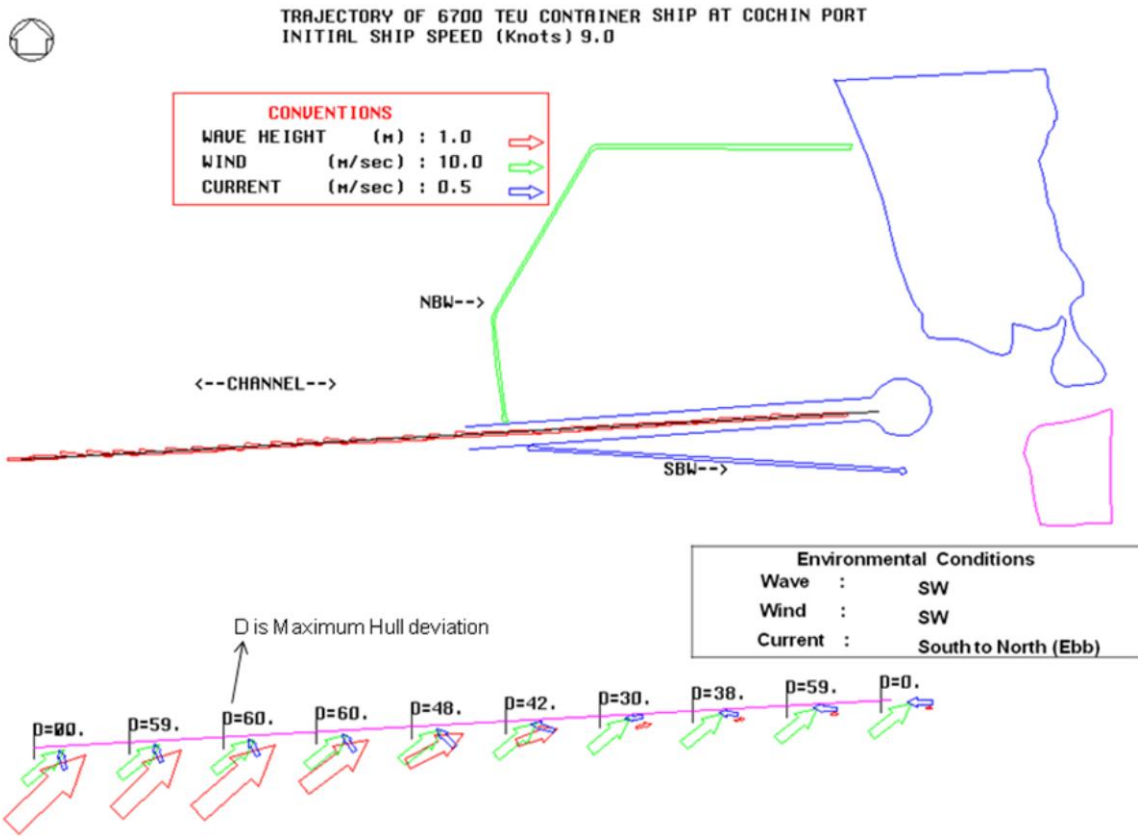
The wave transformation Studies using MIKE-21 SW model, indicated that in the nearshore region of Poompuhar, in 10 m depth, the predominant wave directions are NE, ENE, East, ESE and SE. Wave tranquility studies were carried out for these incident wave directions, with the proposed layout, modified layout and layout modified through physical model studies using MIKE-21 BW model. It was observed that with the proposed breakwater layout, the wave heights in the harbour are in the range of 0.4 m to 0.5 m which are more than the permissible wave height of 0.3 m ,for incident wave directions from NE and ENE with incident wave height of 3m to 3.5m.In order to improve tranquility conditions in the harbor and to minimize probable siltation in the harbor due to northerly drift, the harbor layout was modified. The north breakwater was extended upto -5.5m depth contour to minimize siltation in the harbor. Wave propagation inside the harbour was simulated for the modified layout, with south breakwater of 390 m length and north breakwater of about 1100 m length Wave tranquility studies indicated that the tranquility conditions in the harbor improved with modifications in the harbor layout and wave heights in the harbor area are within the permissible tranquility limit of 0.3m for about 340 days in a year. With the layout modified through physical model studies, harbor basin gets protection against the wave attack and wave heights in the harbor will remain within the permissible limit almost for the entire year. However, it was observed that alignment of the south breakwater may cause hindrance in the navigation of fishing vessels at the entrance of the harbor.

Studies for estimation of littoral drift indicated that net transport in a year is of the order of 0.14 million cum and is towards north. It was estimated that shoreline will advance by about 65m south of southern breakwater in 5 years. The shoreline will erode by about 75 m north of northern breakwater in 5 years.

The modified layout recommended based on the mathematical model studies not only provides adequate tranquillity in the harbour but also reduces siltation in the harbour area due to the littoral drift and is suitable for navigation of fishing vessels.

5119- MATHEMATICAL MODEL STUDIES FOR SHIP MANOEUVERING FOR THE PROPOSED DEVELOPMENT OF OUTER HARBOUR AT COCHIN PORT, KERALA

Cochin port trust have a proposal for the development of an outer harbor terminal at Cochin port, which necessitates the design of the approach channel and harbour basin to cater to large Post Panamax vessels of the size of about 80,000DWT. In this regard, studies were referred to CWPRS to carry out mathematical model studies for simulation of manoeuvering of Post Panamax vessels along the proposed approach channel in order to optimize the width of the approach channel for safe manoeuering of the ships. A design of the fairway has been given based on mathematical model and desk studies. The desk studies carried out following the International Guidelines and Practices, indicated that minimum width required for the Container ship and the oil tankers were 214 m and 247 m respectively, and the depth requirements for the same were 17.1 m and 15.5 m respectively. Mathematical modeling studies for simulation of ship manoeuvering indicated that minimum base width of the channel required for safe manoeuvering of the design ship for the environmental conditions prevailing at the site was about 210m at the start of the approach channel, gradually increasing to 260m at the entrance of the outer harbor for oil tanker. For container ship, minimum width required at the start of the approach channel is about 200m, gradually increasing to 250m at the entrance of the outer harbor.



Trajectory of container ship showing maximum hull deviation for waves from SW direction

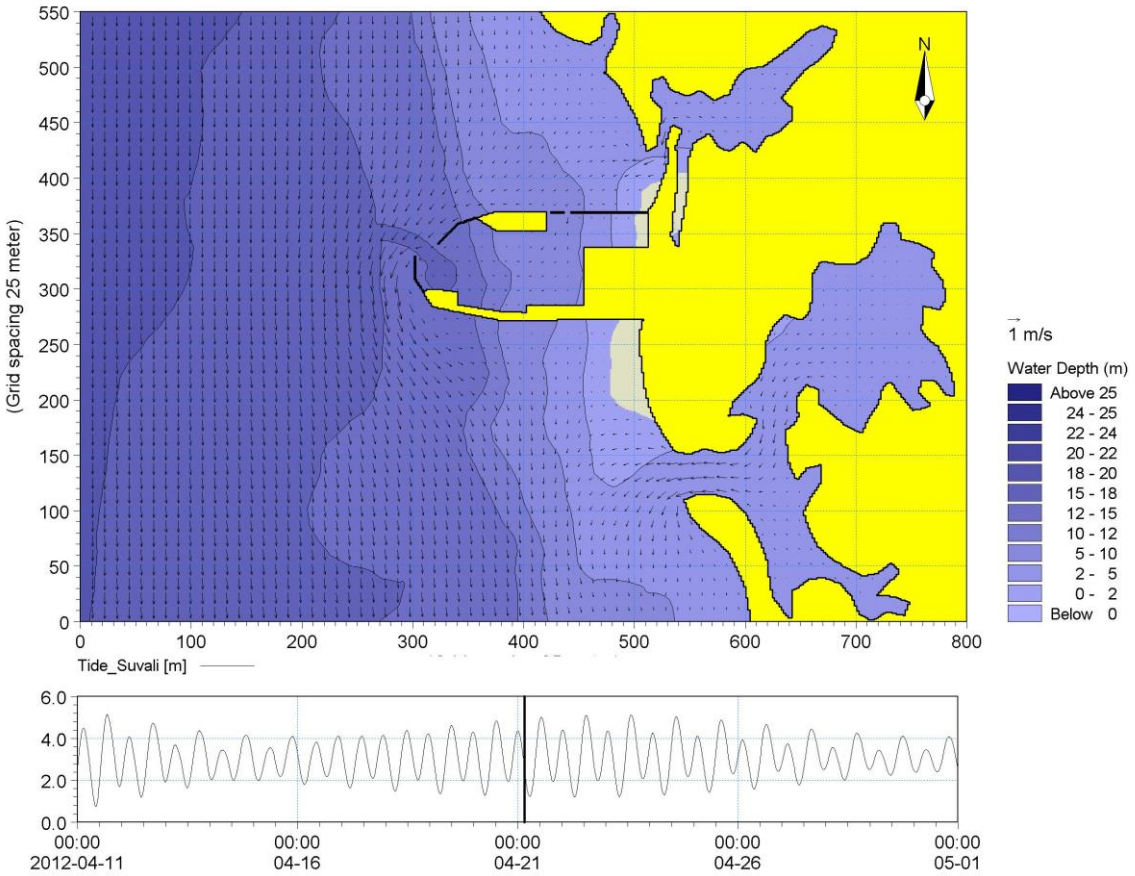
5120-MATHEMATICAL MODEL STUDIES FOR THE DEVELOPMENT OF PORT FACILITIES AT NANDGAON, THANE, MAHARASHTRA

Maharashtra Maritime Board (MMB) have a proposal to develop a multi-cargo port in a green field site at Nandgaon 7 km downstream of Tarapore Point. The proposed port is expected to cater to the captive cargo needs of the MIDC, Tarapore and Vapi Industrial areas. The proposed port consists of 5000 m long Northern breakwater and a 6000 m long Southern breakwater. The approach channel to the port is proposed with of 200 m width and dredged upto -15 m, with a turning circle of 600 m Diameter.

Mathematical model studies were carried out to understand the tidal hydrodynamic behavior and probable siltation pattern in the harbour area with the proposed developments and with the modified layout (Closing of openings in the northern breakwater) of multi cargo port at Nandgaon. The mathematical model developed was calibrated for the existing conditions with the available data. Hydrodynamic studies with the proposed development indicate that the magnitude of current inside the harbour basin are in the range of 0.2 to 0.33 m/sec which at the tip of the breakwater the flow velocities have increased marginally as compared with the existing condition and are in the range of 0.8 to 1.0 m/sec. From the sedimentation studies it is observed that the average depth of deposition in the approach channel varies from 20 to 35 cm over a period of six months covering monsoon season. The estimated sedimentation in the entire harbour region including approach channel and turning circle would be of the order of 0.95 MCum per annum.

Hydrodynamic studies with the modified layout indicate that there is little variation in the magnitude of currents in the harbour area (0.2 to 0.3 m/sec) and at the tip of the breakwater near approach channel entrance (0.8 to 1.0 m/sec) as compared to the proposed condition. From the sedimentation studies it is observed that the sediment deposition has slightly reduced because of the closure of opening in the northern breakwater with no significant trend of deposition in the approach channel. The estimated sedimentation in the entire harbour region including approach channel and turning circle would be of the order of 0.60 MCum per annum.

From the hydrodynamic studies it is concluded that the flow field is conducive with both the layouts without significant circulation. Sedimentation studies reveal that maintenance dredging is more in the case of proposed layout as compared to modified layout. Even though maintenance dredging is more in modified layout the advantage of circulation of sea water from the northern breakwater will helpful in tidal circulation aspect for development of multi cargo port. Provisions may be made for the periodical maintenance dredging to maintain adequate depths in the channel and basin.

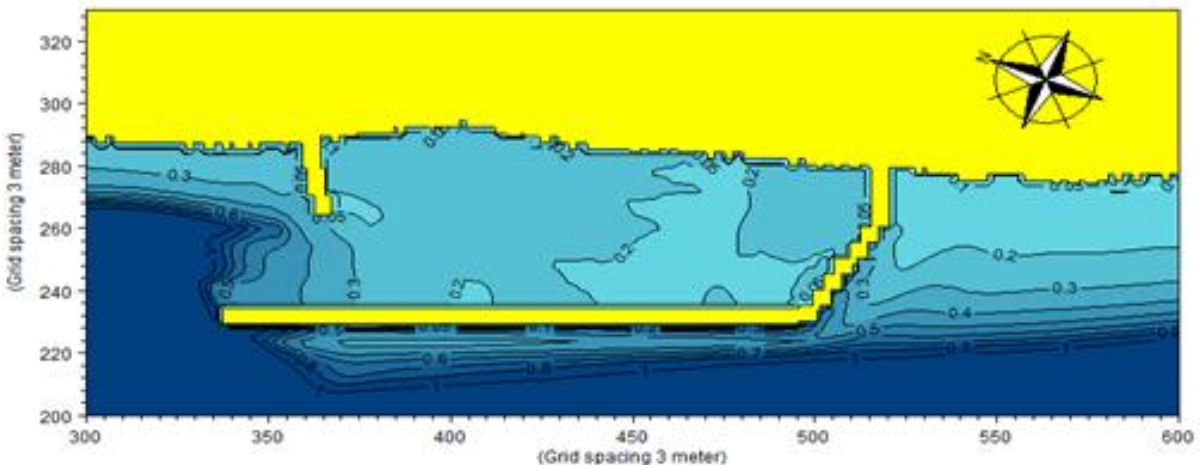


Flow field during peak ebb (proposed layout)

5127-MATHEMATICAL MODEL STUDIES FOR WAVE TRANQUILITY FOR THE PROPOSED DEVELOPMENT OF FISHING HARBOUR AT POONTHURA, KERALA

The Harbour Engineering Department (HED), Kerala, has a proposal to develop fisheries harbour at Poonthura located on the west coast of India in Kerala at about 6km south of Thiruvananthapuram. The proposed layout by HED consists of two breakwaters, 80 m long north breakwater and 670 m south breakwater (150 m normal to the shore and 520m along the shore) with 100 m wide opening at the harbour entrance. Mathematical model studies for assessment of wave tranquility in the mini fishing harbour were carried out in two stages, firstly the transformation of wave height and wave direction from deep water to 11 m depth using OUTRAY model followed by simulation of wave propagation in the harbour to obtain wave height distribution in the harbour using MIKE21-BW model.

The studies indicated that with the proposed layout, with berths/ jetties on the lee side of both the breakwaters, the harbour can be safely operated for about 300 days in a year. The annual net littoral drift estimated is of the order of 0.1 M m3 with its direction towards south. The studies further indicated deposition on north side of the north breakwater, and erosion on the south side of the south breakwater at Parappanangadi site is predicted in the range of 100 m, and its longshore impact would be felt in the range of 2 km to 3 km. The coastline in the range of 2 km to 3 km on south side, which is prone to recession, is required to be protected by coastal protection works, say sea wall/ groins. Also, periodical maintenance of the Murithodu(drain) mouth in the vicinity of the south breakwater may be required for keeping the mouth open.



Wave distribution plot for proposed layout for incident wave height of 3.5m and direction WSW

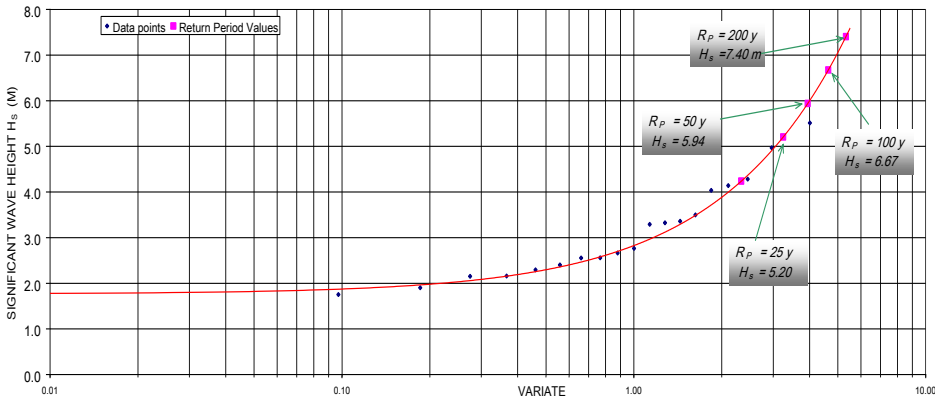
5129-5137- DESIGN CONDITIONS FOR DEVELOPMENT OF PORT FACILITIES AT NANDGAON, THANE, MAHARASHTRA

Maharashtra Maritime Board (MMB) proposes to develop port facilities at Nandgaon in Thane district of Maharashtra on the northern periphery of Thane district in Maharashtra. The proposed port is located about 7 km south of the Tarapore point, Maharashtra. Studies for wave hindcasting storm surge analysis using storm data were carried out for estimation of design wave conditions storm surge at the coast of Nandgaon considering the storm data for the period 1981 and 2010 (30 years). 49 cyclones which are significant for Nandgaon coast have occurred during this period.

The storm wave hindcasting analysis was carried out using a semi-empirical method developed by Sverdrup, Munk and Bretschneider (SMB Method) for deriving deep water wave parameters from the cyclonic parameters like pressure drop, wind speed, location and duration of the storm, fetch length and decay distance. The deep water wave conditions were then transformed to near shore zone by using MIKE21 Spectral Wave (SW) model. Analysis was also carried out to determine the storm wave values from various cyclonic parameters using Sylvester's method. The hindcast data of the wave heights were subjected to extreme value analysis using Gumbel (Type-I), Weibull and Log–Normal distributions to determine the values for different return periods.

The extreme value analysis of the hindcast storm surge data indicated a storm wave value of 7.1 m, 6.5 m, 5.8 m and 5.1 m for (200-years, 100-years, 50-years and 25-year return period respectively) for the Nandgaon coast, which can be considered for the design of breakwater at Nandgaon port.
The storm surge analysis was carried out using an empirical method developed by Sylvester, from the cyclonic parameters like pressure drop, wind speed, location and duration of the storm and fetch length. The hindcast data of the surge heights were subjected to extreme value analysis using Gumbel (Type-I), Weibull and Log–Normal distributions to determine the storm surge values for different return periods.

The extreme value analysis of the hindcast storm data indicated a storm surge value of 2.9 m, 2.6 m, and 2.3 m for 100-years, 50-years, and 25-year return period respectively for the Nandgaon coast. These values would be useful to arrive the extreme water level conditions for the proposed development of Port facility at Nandgaon.

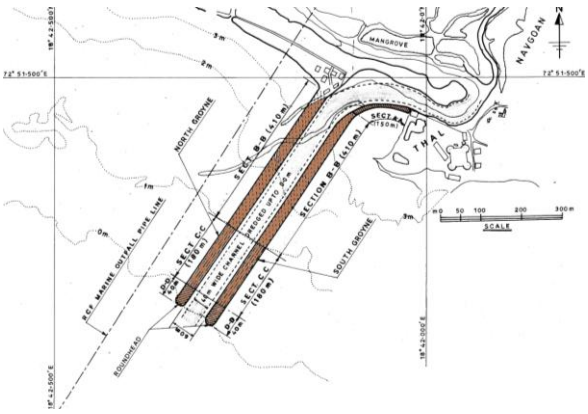


Hindcast wave data of Nandgaon coast on Gumbel distribution (at 40 m depth)

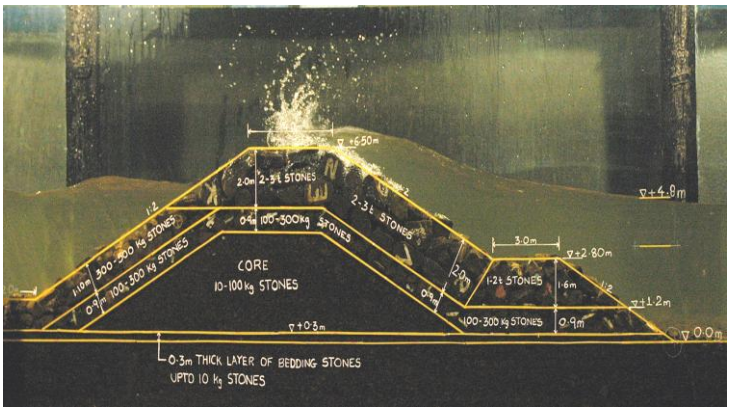
5138-DESIGN OF TRAINING WALLS FOR THE NAVIGATIONAL CHANNEL AT THAL, RAIGAD, MAHARASHTRA

A fertilizer plant of RCF (Rashtriya Chemicals & Fertilisers Ltd.) is located on the eastern side of Thal in the district of Raigad in Maharshtra. RCF marine outfall pipeline (60 cm dia.) laid across the shoreline at Thal is getting exposed in the navigational route of the fishing boats during the lower water levels causing obstruction in navigation of the fishing boats. To overcome this problem, the Harbour Engineering Division, Government of Maharashtra proposed shifting of the existing navigational channel and construction of training wall to guide the flow.

Based on the hydraulic studies carried out two parallel training walls to guide the flow and maintain the depths for navigation of fishing boats have been recommended. The layout consists of 630 m long South & North training wall extending up to 0.0 m contour. Based on the site specific data regarding bathymetry, wave conditions and tidal levels, conceptual design of cross-sections were evolved using the empirical methods. The hydraulic stability tests were conducted in the 40 m long regular wave flume by reproducing the sections to a Geometrically Similar (GS) model scale of 1:20. The training wall section consists of 1 t -2 t stones in the armour placed at 1:2 slope for the root of groyne to +1.0 m bed level, 2 t-3 t stones in the armour for +0.0 m bed level. A roundhead portion was suggested with 2 t - 3 t stones in the armour placed at 1:2 slope for 0.0 m bed level. The sections were found stable upto a design breaking wave height of 3 m, hence were recommended for construction.



Fishing harbour layout



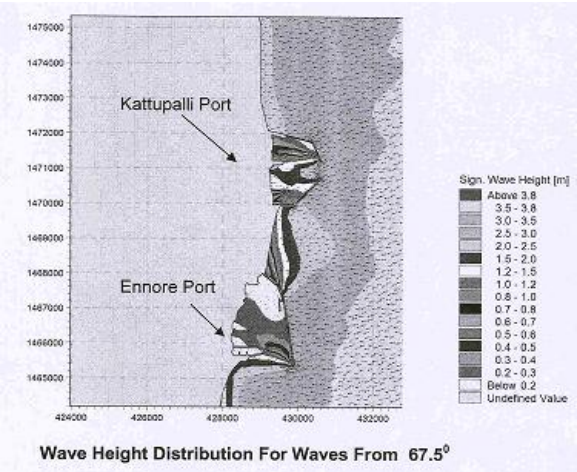
Wave flume-stability test of breakwater

5141-5142-MATHEMATICAL MODEL STUDIES FOR WAVE TRANSFORMATION AND MORPHOLOGICAL CHANGES IN THE COASTLINE AT ENNORE

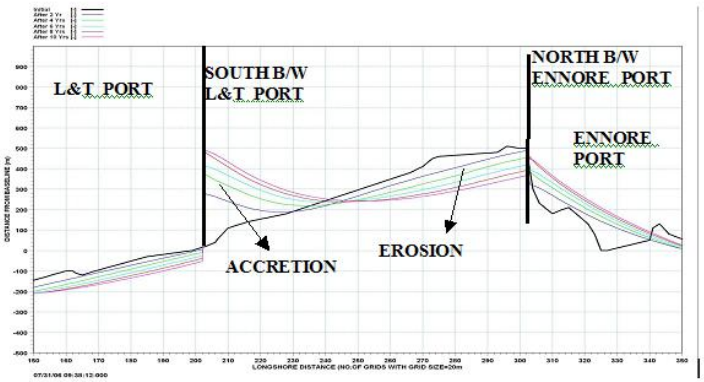
M/s Ennore Port Ltd (EPL) desired to carry out R & D studies related to integrated morphological changes on the coastline between Ennore and L&T ports constructed during 2012 and 2013 respectively. The scope of the studies was to examine wave conditions and evolve shoreline changes between north breakwater of Ennore port and south breakwater of L&T port using mathematical modelling techniques. The wave transformation studies indicated that in the near shore of Ennore port and L&T port, in 12 m depth, the predominant wave directions are from ENE, East, ESE and SE. Maximum significant wave heights observed in the area between Ennore port and L& T port are of the order of 1.5 m to 2.0 m. Construction of L&T Port has a negligible effect on the wave climate in the coastal stretch between Ennore and L&T Ports.

The mathematical model studies for shoreline changes indicated erosion in the north side of Ennore Port and accretion in the south side of L & T port which was duly supported by google imageries. For the northern portion of north breakwater of Ennore port, there will be alongshore erosion for 1.1 km and cross-shore erosion for 150 m in a period of 10 years. For the southern portion of the south breakwater of L & T Port, there will be alongshore accretion for 0.9 km and cross-shore accretion for about 450 m in a period of 10 years.

The phenomenon of erosion and accretion between the two breakwaters is a local phenomenon. The erosion in southern part of the beach can be taken care by the nourishment. To avoid longshore sediment movement from the nourished beach, coastal protection with construction of 40 m long groynes at an interval of about 100 m along the eroding coast may be provided.



Wave Height Distribution For Waves From 67.5^0

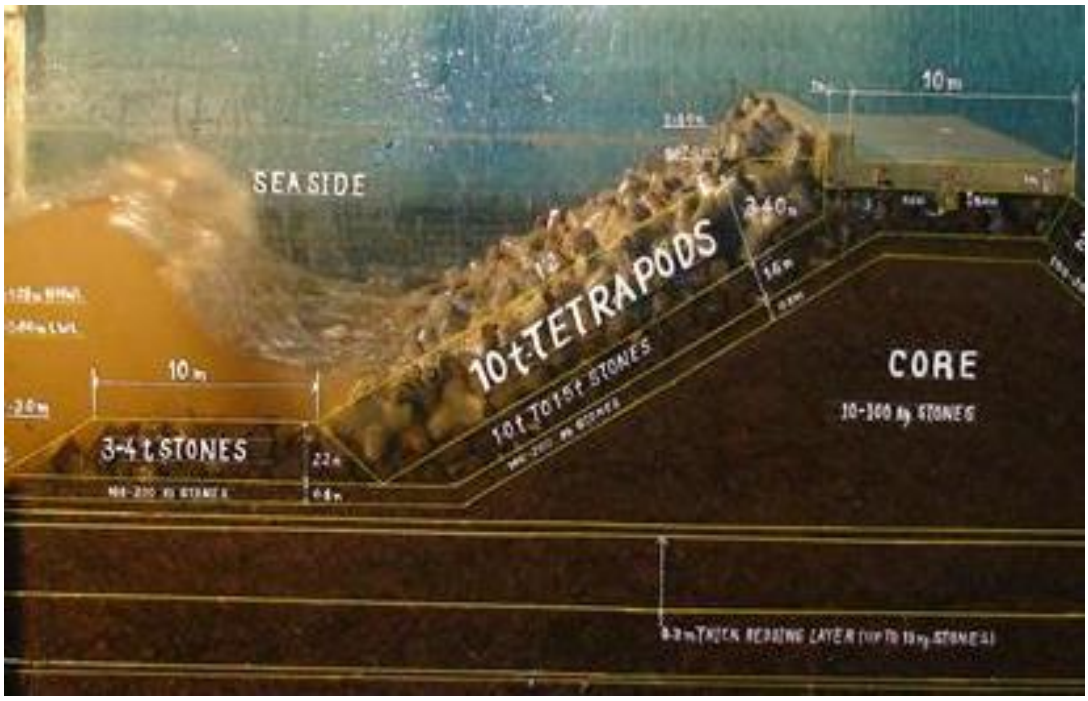


Shoreline changes after 2, 4, 6,8,10 years

5143-WAVE FLUME STUDIES FOR THE DESIGN OF BREAKWATER FOR THE PROPOSED DEVELOPMENT OF OUTER HARBOUR AT COCHIN PORT, KERALA

Cochin Port is a major port of India along Mattanchery Channel and Ernakulam channel in the state of Kerala. The Master Plan for development of Cochin Port envisages construction of an Outer Harbour at the Puthuvypeen Island to cater liquid cargo consisting of LNG/LPG, crude oil and POL products, chemicals etc. The Cochin Port Trust (CoPT) appointed M/s I-Maritime Consultants Pvt. Ltd. as the Consultants for preparing the feasibility report for the development of Outer Harbour at Cochin. The development proposal of outer harbour consists of two long breakwaters on either side of Cochin Inlet. North breakwater is about 6.7 km long and the most of the reclamation area and the berths are lying on the leeside of North breakwater. The 4.5 km long South breakwater is an offshore type of breakwater. The Chief Engineer, Cochin Port Trust requested CWPRS to carry out studies to evolve the design of breakwater cross-sections of the proposed outer harbour at Cochin.

Desk and wave flume studies were conducted to design the cross-sections of the north and south breakwaters. The proposed cross-sections for trunk at -2 m, -5 m & -7 m bed levels consists of 4 t, 6 t & 10 t Tetrapods on 1:2 slope in the armour. The top level of the 10 m & 6 m wide crest were kept at +7 m for the north and south breakwaters respectively. These sections are stable under the design wave height of the order of 4.5 m for zero order damage (i.e. less than 1%). The design of the roundheads were evolved for the north and south breakwater at -7 m bed level, which consist of 12 t Tetrapods on 1:2 slope in the armour.



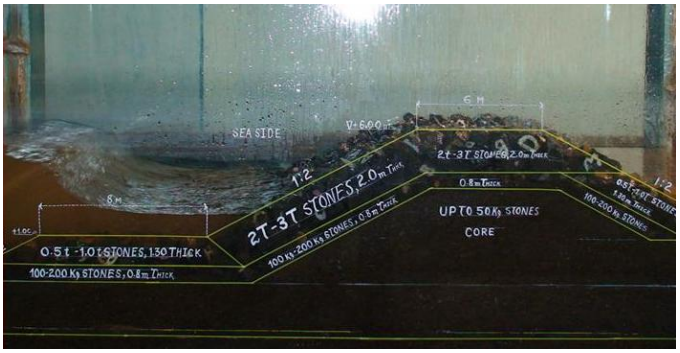
Testing of trunk section at the highest high water Level

5144-WAVE FLUME STUDIES FOR STRENGTHENING OF EXISTING SEAWALL FOR SEASHORE TEMPLE AT MAMALLAPURAM, TAMILNADU

The ancient shore temple at Mamallapuram is located about 60 km south of Chennai. This place attracts tourists from all over the world. Mamallapuram otherwise known as Mahabalipuram has been declared as a world heritage site by UNESCO. The temple has been subjected to the effects of salt laden winds and salt water spray by wave action due to which some of the granite stones have undergone disfiguration with time. Further the changes in the coastline at the temple area have also threatened the stability of the temple itself. The north side of 'L' shape seawall got damaged severely and most of the armour and secondary layer stones are displaced. It is also observed that, eastern arm of the seawall is almost intact, with stones displaced at some locations leaving pockets. The armour layer of the roundhead of the seawall also got damaged to a certain extent. It is also observed that, the existing seawall was not provided with toe. Good beach has been formed on the south as well as on the north side of the temple. The Superintending Archaeologist, Archaeological Survey of India, Chennai Circle, has referred the studies for strengthening the existing seawall near the seashore temple at Mamallapuram.

Desk and wave flume studies were conducted to design the cross-sections of the existing seawall. The proposed cross-sections for trunk at -1.10 m bed levels consist of 2 t – 3 t stones on 1:2 slope in the armour. The top level of the 6 m wide crest were kept at +6 m for the seawall. This section is stable under the design wave height of the order of 3 m for zero order damage (i.e. less than 1%). The design of the roundheads were evolved for the existing seawall at -1.10 m bed level, which consist of 2 t - 3 t stones on 1:2.5 slope in the armour.

Location map of Shore Temple, Mamallapuram



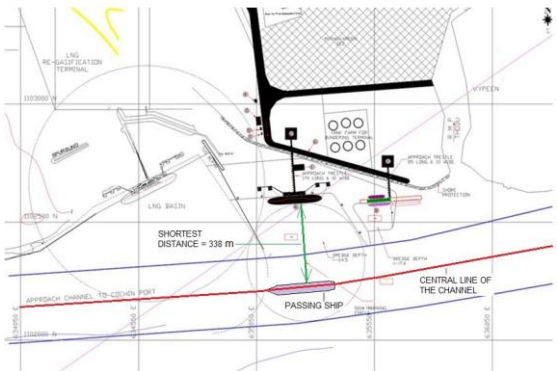
Testing of trunk section at HHWL

5147-SHIP MOORING ANALYSIS FOR REVISED ALIGNMENT OF MULT JETTY AT COCHIN PORT, KERALA

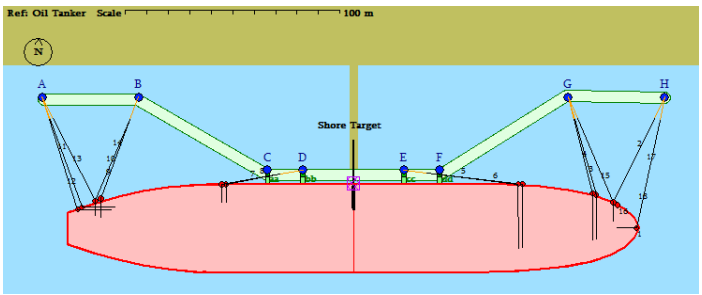
Cochin Port has a proposal to develop Multi User Liquid Terminal (MULT), a jetty for Oil Tankers and LPG Vessels at PuthuVypeen near the entrance to Cochin Port. In this regard ship mooring analysis was carried out at CWPRS, considering MULT jetty alignment as 75^0N/255^0N. Software OPTIMOOR developed by M/s Tension Technology International, UK has been used for the analysis. Studies were carried out to simulate the moored ship motions for LPG vessels and Oil Tankers covering range of the sizes of vessels expected to deliver at the berth. The Super Cone Fender of 2 m height was found suitable for the berthing of the ships The bigger Vessel were moored with steel wire attached with nylon tail, whereas the smaller ships were moored with polypropylene rope. The maximum motion amplitudes of moored ships in six degrees of freedom, loads in mooring lines and fender compressions were obtained and all these values are well within the safe operational limits as specified by PIANC for all the ships.

Alignment of MULT jetty was revised as 86^0N / 266^0N i.e. parallel to the navigation channel and the mooring analysis was carried out for the environmental conditions recommended by OCIMF to achieve operating limits applicable to the biggest and smallest ship i.e., 80000 DWT Oil Tanker and 5400 DWT LPG Vessel.

It was observed that, for the Oil Tanker (80000 DWT), all the motions are within the permissible limit and the mooring ropes, bollards and fenders are safe even in extreme environmental conditions. Whereas for LPG Vessel (5000 DWT), only surge motions are more than the safe recommended limits of 2m which occur only in severe storm conditions for wind speed of 50 knots or more. There is no failure of mooring line, bollard or fender. Also the maximum bollard pull is within the limit for both the ships. Mooring analysis shows that there are no operationally unacceptable ship responses. On the basis of these results, downtime of the berth caused by normal environmental condition, is expected to be infrequent.



Revised alignment of mult jetty



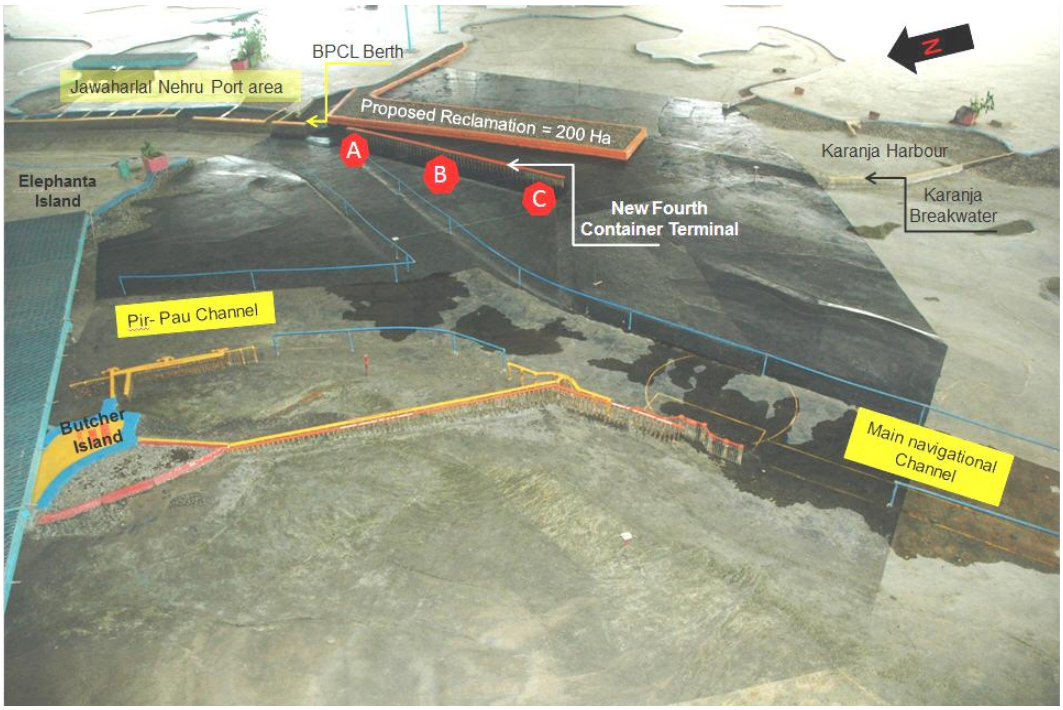
Mooring arrangement of 80000 DWT oil tanker at Mult jetty

5150 -PHYSICAL MODEL STUDIES FOR DEVELOPMENT OF FOURTH CONTAINER TERMINAL AT JAWAHARLAL NEHRU PORT, MUMBAI

The Jawaharlal Nehru Port (JNP), one of the major ports of India is situated on the West coast in Thane Creek, have referred the various studies in the past to CWPRS for the development of fourth Container terminal along with other berthing facilities like chemical berth, LNG; which are to be developed in three phases alongwith 200 Ha of reclamation on leeside of the container terminal. The development of Container terminal was proposed in two phases with Phase-I and Phase-II development having length of 1000m each. The CWPRS had submitted a report bearing No.4299 of January 2006 for the above proposal and orientation of the terminal was recommended at 42^0 N at 60^0 N respectively for Phase-I & Phase-II proposals.

The JNP now desires to have development of fourth container terminal as a 2000 m long container terminal in one line on South of existing BPCL berth in order to have maximum usage of berth/quay length for berthing and handling of containers along with 200 ha reclamation in rectangular shape on leeside of proposed terminal. The layout of this terminal was prepared by M/s TATA Consulting Engineers (TCE) and to assess the suitability of alignment of fourth container terminal from tidal hydrodynamic considerations, model studies were carried out on the existing physical tidal model of Mumbai Port (Scale 1:400 H, 1:80 V), wherein tides are generated by automatic tide generating system.

The studies indicated that the proposed layout of fourth container terminal needs to be modified both for alignment and shape/location of reclamation (200 Ha) which will allow safe berthing of container carrier all along 2000m length during various phases of tides.

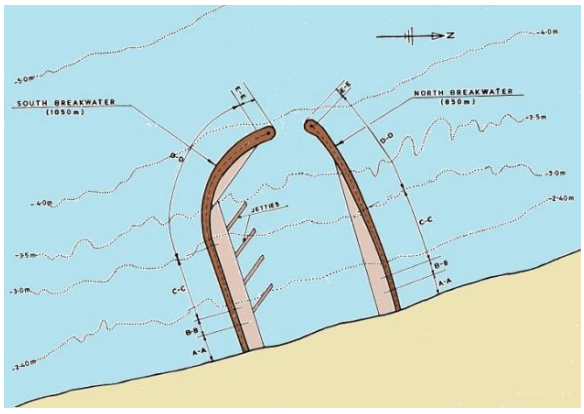


Layout of 4th container terminal studied on physical model (2000 m long terminal in one line)

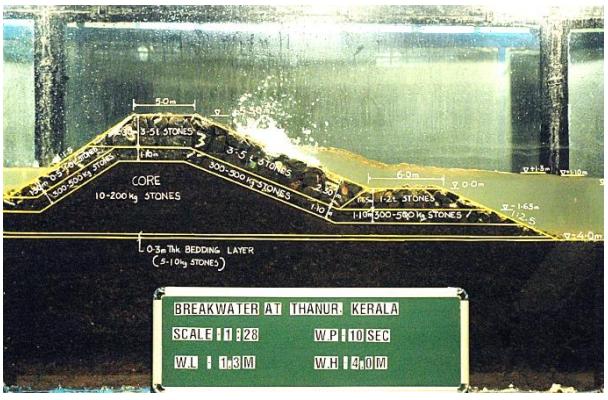
5156-DESIGN OF BREAKWATERS FOR DEVELOPMENT OF FISHERY HARBOUR AT THANUR IN MALAPPURAM, KERALA

Thanur is a small town situated along the open coast at about 25 km south of Beypore, in Malappuram District of Kerala. Fishing is one of the main sources of livelihood of the people of Thanur. Keeping in view the difficulties of the fishermen in berthing operation due to assailing waves from the Arabian sea, Harbour Engineering Division (HED), Government of Kerala has proposed to develop fishery harbor at Thanur. The mathematical studies carried out in CWPRS for wave tranquility, shoreline changes, hydrodynamics and siltation inferred the suitability of the layout of the proposed fishing harbor at Thanur. The recommended layout consists of a shore connected north and south breakwaters of about 850 m length and 1050 m length respectively, which are extended upto -4.0 m depth contour.

Based on the site specific data regarding bathymetry, wave conditions and tidal levels, conceptual design of breakwater cross-sections evolved were using the empirical methods. The hydraulic stability tests were conducted in the 40 m long regular wave flume by reproducing the sections to a Geometrically Similar (GS) model scale of 1:28. The breakwater section consists of 3 - 5 t Stones in the armour placed at 1:2.5 slope evolved at -4.0 m bed level. Two alternative cross-sections at -4.0 m bed level as well as for the roundhead with 3 - 5 t stones & 4 t tetrapods in the armour at 1:2.5 armour slope have been suggested. Five different cross-sections with respect to various bed levels have been suggested. The sections were found stable upto a design breaking wave height of 4 m, hence were recommended for construction.



Layout of breakwaters

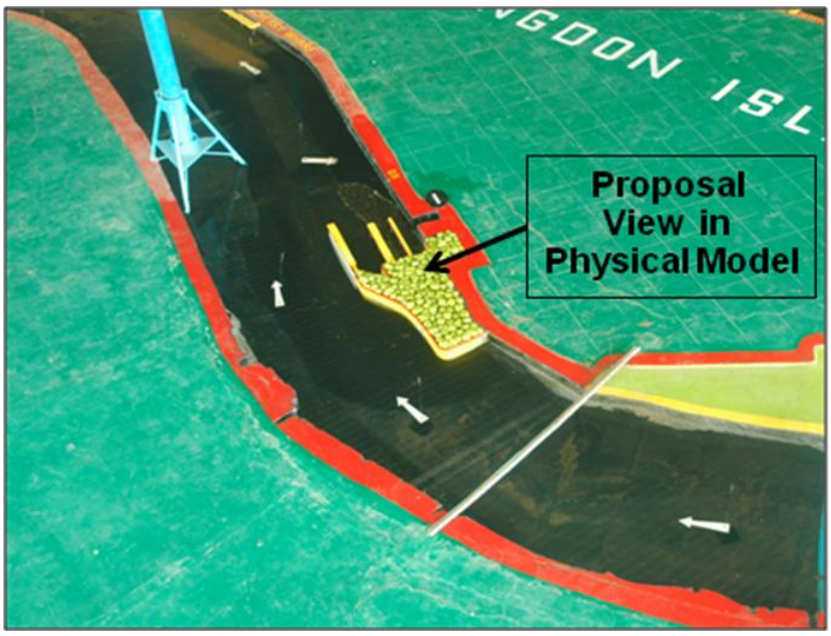


Wave flume test for breakwater

5157-PHYSICAL MODEL STUDIES FOR ESTABLISHING A SHIP REPAIR FACILITY IN MATTANCHERRY CHANNEL AT COCHIN PORT, COCHIN

The Cochin Port Trust (CopT) has a small dry dock and marine workshop at the southern end of Willingdon Island, facing Mattancherry channel for carrying out the repair and maintenance of the port craft such as ships and vessels. A proposal has been mooted by the CoPT for expanding the facilities and establishing commercial ship repair facility by adding more backup area and water frontage. CoPT proposes to establish the ship repair facility in the Mattancherry channel near the existing dry dock and develop infrastructure for ship lifting and ship repair yard with six parking bays for which it is proposed reclaim a part of the right bank of Mattancherry channel about 350 m north of Mattancherry bridge. The bottom part near to ship lift facility and Afloat repair berth is to be dredged and maintained to (-) 6m and (-) 6.5m below chart datum (CD) respectively. The physical model studies were carried out at CWPRS using a distorted model (scale: 1/80 V, 1/800 H) to study flow patterns and morphological changes on temporal scale.

The proposed development has been modeled as a geometrical distorted model with scale of 1:80 V and 1:800 H. The whole assembly has been tested in a physical model for flow patterns and morphological changes on temporal scale. It was observed that the flow conditions around the proposed ship repair facility would not be conducive for natural maintenance of dredged depths consists of eddy flows caused basically due to the obstruction to flow by way of proposed reclamation. It was concluded that this proposal would not be conductive for natural maintenance of dredged depths.. The proposal may need to be modified by shifting the location of the ship lift and modifying the parking bay reclamation to have partly reclaimed soil and partly of RCC deck supported on piles.

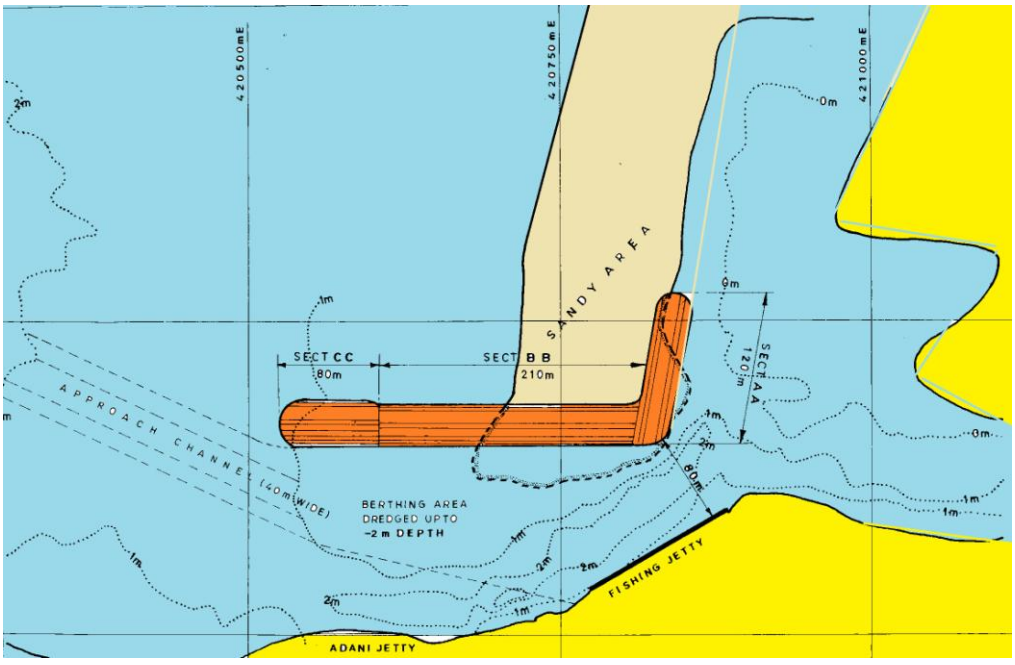


Proposal tested in physical model of Cochin Port

5158-DESIGN OF TRAINING WALL/GROYNE FOR THE DEVELOPMENT OF FISH LANDING CENTRE AT BELEKERI, KARNATAKA

A small fish landing centre at Belekeri is located in Uttar Kannada District on the west coast of India, Karnataka. This fish landing centre is situated in the mouth of the creek with a clear width of about 80 m at the mouth and well protected from the direct waves. Sediment deposition takes place at the entrance of the creek due to adjacent beach sand movement which there is no sufficient flushing action due to weak currents. The area being engaged in fishing activity, the fishermen are facing difficulties in navigation of fishing boats due to shallow draft. In order to facilitate the smooth navigation and berthing of boats for fishing activity, Port Division, Baithkol, Karnataka has proposed to develop full-fledged fish landing centre at Belekeri.

The proposal consists of construction of training wall/groyne at the entrance of the creek to avoid the sediment movement in the mouth of the creek and to facilitate the flushing of sediments from the creek mouth. This proposal helps in increasing velocity for flushing of sediment through entrance and smooth navigation and berthing of fishing boats. Based on the studies, a layout plan of 200 m long training wall/Groyne and bank protection inside the creek has been recommended. The proposal also consists of 40 m wide channel, which is to be dredged up to -2 m depth (wrt CD). The breaking wave height of the order of 2.1 m for the training wall/groyne was considered in the design of cross-sections. The armour weight was evolved using Hudson's formula. The roundhead portion of the training wall/groyne section consist of 1 to 1.5 t stones, its trunk portion consists of 800 to 1000 kg stones in the armour in the sea side and 500 to 800 kg stones in the channel side which the bank protection consists of 200 to 300 kg stones in the armour. The training wall/groyne and bank protection are expected to guide the flow as well as to stabilize the inlet, which will facilitate smooth navigation of fishing boats.



Proposed training wall/ groyne for development of fish landing centre at Belekeri, Karnataka

5159-HYDRAULIC PHYSICAL MODEL STUDIES FOR FLOTILLA BERTHS AT NEW MANGALORE PORT

New Mangalore Port, one of the major ports of India, is located on the west coast of India (Lat.12° 55′ N, Long. 74° 48′ E) in Karnataka state. It is an artificially developed lagoon type of all weather port developed in stages over the last four decades to suit the growth in the traffic requirements. The port has a proposal to construct Flotilla Berths for the floating crafts near the existing spending beach on the eastern boundary of the port basin. The flotilla comprises small crafts of the port like Tugs, Pilot Launches, Multipurpose Vessels, Survey Launch and Mooring Launches. The physical wave model studies on the existing model (scale 1:120 G.S.) using random sea wave generation facility. The studies were conducted for the most critical wave incident directions viz.., West, South-West and North-West.

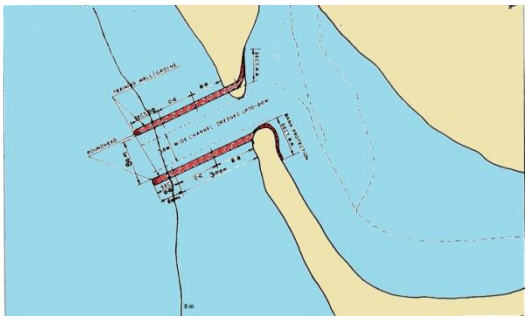
The studies indicated that the wave tranquillity is adequate for the berthing jetties for all the tested conditions on the model for most part of the year. It was suggested to allocate suitable berthing locations for different flotilla vessels depending on the vessel tranquility requirement. During the periods of severe wave climate, the berthing could be relocated to east-west face in the Eastern and Southern Dock arms as per present practice. The individual jetty alignments were finalized after the model studies. The proposed flotilla jetty was suggested with a piled structure with spending beach on the eastern side to help in wave energy dissipation inside the harbour basin.

Photo showing Flotilla Jetties simulated on the model

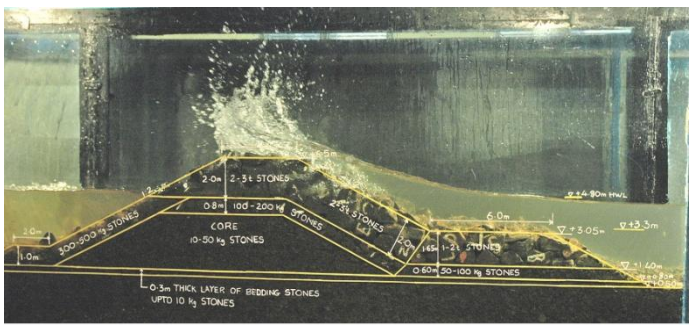
5160-DESIGN OF GROYNES FOR THE NAVIGATIONAL CHANNEL AT THERONDA, RAIGAD, MAHARASHTRA

Theronda is situated at about 15 km south of Alibag on the west coast of Maharashtra. The village is located well inside the Theronda creek at about 700 m apart from the open coast. The mouth of creek is experiencing heavy deposition of sediments during non-monsoon period, thereby decreasing the waterway to a considerable extent. The fishermen are facing difficulties in navigating the vessels due to narrow entrance and shallow depths at the mouth. In order to improve flow conditions in the creek the Maharashtra Maritime Board (MMB) proposed to dredge navigational channel and to construct groynes/training walls at the mouth of the Theronda creek to assure the safe navigation in the channel.

Two parallel groynes were proposed based on the mathematical model studies carried out to study the tidal hydrodynamics and sedimentation of the project area with the proposed facilities. The layout consists of 360 m long South & North training wall extending up to 0.0 m contour. Based on the site specific data regarding bathymetry, wave conditions and tidal levels, conceptual design of cross-sections were worked out using the empirical methods. The hydraulic stability tests were conducted in the 40 m long regular wave flume by reproducing the sections to a Geometrically Similar (GS) model scale of 1:20. The groyne section consists of 1 -2 t stones in the armour placed at 1:2 slope for the root of groyne to +1.5 m bed level, 2 -3 t stones in the armour for +0.5 m bed level. A roundhead portion is suggested with 3 - 4 t stones in the armour placed at 1:2 slope for 0.0 m bed level. An alternative design for roundhead portion with 2 t tetrapods in the armour of groynes is suggested. In order to combat bank erosion at the mouth of the creek, a design of bank protection work with 100-300 kg stones in the armour is also suggested. The sections were found stable upto a design breaking wave height of 3 m, hence were recommended for construction.



Layout of training walls/groynes



Wave Flume test for training walls/groynes

5164-MATHEMATICAL MODEL STUDIES FOR SHORELINE EVOLUTION FOR PETRONET LNG TERMINAL AT KOCHI, KERALA

M/s Petronet LNG Ltd. (PLL) has a marine terminal for import of LNG on accreted land at Vypeen near the entrance of Cochin Port in Kerala on the west coast of India. The LNG terminal was facing severe problem of siltation in and around its terminals due to littoral drift. The phenomenon of excessive longshore sediment transport was observed at the LNG site in the year 2011, when a groyne of 130 m length was constructed in the north of the terminal to prevent siltation in the vicinity of terminal caused due to littoral drift. It is reported that the accretion of about 70 m occurred on the northern side of the groyne within a period of the first four months of monsoon season and during subsequent seasons, the shoreline further advanced by 20 to 25 m. In present condition, the groyne does not play significant role in arresting the southward littoral drift as most of the drift is being bypassed and getting deposited in the vicinity of the terminal. In order to prevent or minimise the siltation due to southward littoral drift in the vicinity of LNG terminal, it is proposed to extend the length of the existing groyne by 500 m and mathematical model studies, using MIKE 21 SW and LITPACK, have been carried out to assess littoral drift distribution and changes in shoreline at the proposed location for the post extension scenario of the existing groyne. Based on the model studies it is inferred that the annual southward and northward transports were of the order of 0.925 million cum and 0.265 million cum respectively with the net and the gross transports being 0.66 million cum and 1.19 million cum respectively. The net longshore transport is towards south and occurs primarily during SW monsoon. The longshore sediment transport is confined within a range of 3000 m from the shoreline. The peak transport occurs at about 200 m from the shoreline and about 75% transport occurs in the range of 50 m to 1000 m from shoreline i.e. between +0.5 m to −2.5 m depth contours. In 10 years period, accretion on the northern side of the groyne is limited upto about one third (175 m) of the extended length (500 m) of the groyne, but it would arrest only partial littoral drift as the surf zone would be extended upto 2.5 km especially during SW monsoon.

Layout of LNG terminal at Cochin

5165-HYDRAULIC MODEL STUDIES FOR PROPOSED MUMBAI TRANS HARBOUR LINK (MTHL) PROJECT AT MUMBAI

Mumbai is traditionally the epicenter of India's commerce. Despite obvious spatial constraints, Navi Mumbai has been identified as an alternative destination for easing the pressure of development on the island city. Many suburbs are being developed in Navi Mumbai area on the eastern side of Mumbai in line with the above problem. However, due to lack of connectivity to the mainland, it has stunted the growth and continues to mount the pressure on the island city's infrastructure. Mumbai Metropolitan Region Development Authority (MMRDA), in this context have a proposal to provide about 22 km long road link between Sewri on the island city(Mumbai) and Chirle on Main land by constructing Mumbai Trans Harbour Link (MTHL).

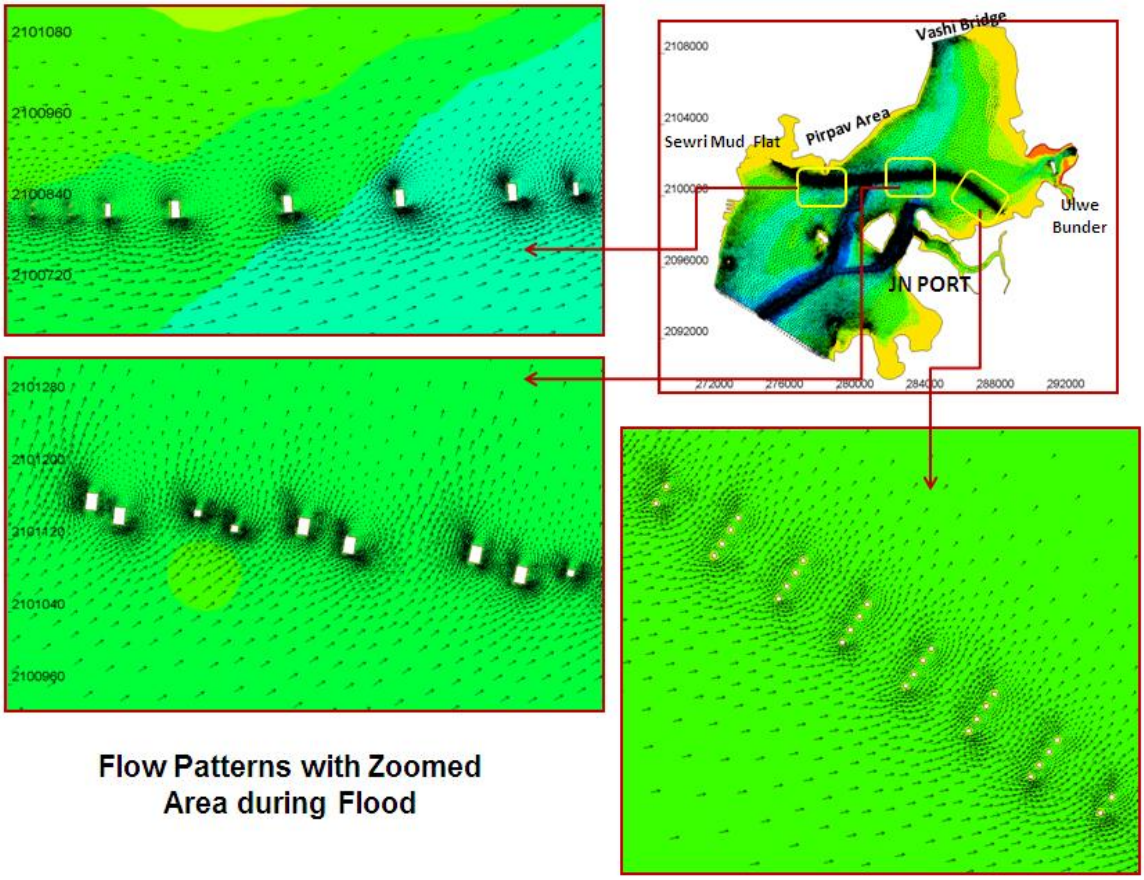
CWPRS in the past had conducted a number of studies for two alternatives with southern and northern link consisting of reclamations for approaches to the bridge. The earlier studies by CWPRS inferred that detailed model studies are required to be carried out before grounding the project.

The present proposal of bridge consisst of entire deck resting on piers and transferring the load to the ground through piles without any reclamations for approaches to the link/bridge. In view of bridge being spanning across the entire width of Thane creek, MMRDA desired to study the effect of obstruction of large number of piles on the tidal hydrodynamics of Thane creek wherein two major ports i.e. Mumbai and Jawaharlal Nehru port along with other marine facilities are located. The hydraulic studies were carried out to assess the effect of MTHL by developing a mathematical model for Mumbai region using Finite Element modeling technique.

The calibrated model was modified to incorporate the bridge alignment with number of piles and based on hydrodynamic studies carried out, effect of bridge on flow hydrodynamics was studied. The studies reveaed that effect of MTHL on the existing waterfront facilities such as Intake jetty at BARC-Trombay, BPCL and NSICT berths in JNPT area, Marine oil terminal (MOT) near Jawahar Dweep of Mumbai port etc from hydraulic considerations was negligible. The facilities near Pir-Pau area being in close proximity, there would be reduction in the existing current strength by about 10%.

Further, it was found that the overall effect of MTHL on hydrodynamics will be less than even 2% of total tidal flux entering or leaving Thane creek. The studies revealed that the proposal of MTHL has no detrimental effect on the prevailing hydrodynamics of the Thane creek.

Location plan of proposed MHTL bridge over Thane creek

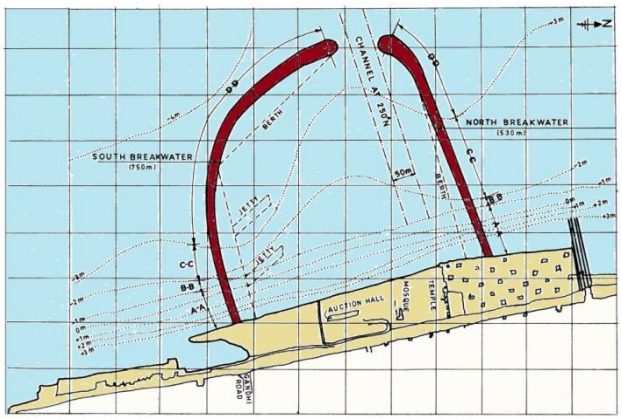


Flow pattern during typical flood tide with piles of MTHL bridge

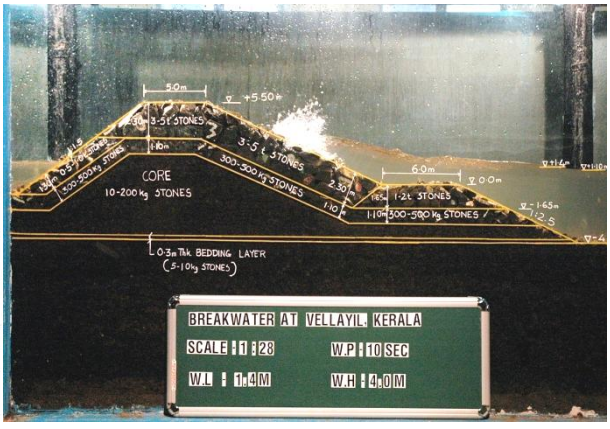
5166-DESIGN OF BREAKWATERS FOR DEVELOPMENT OF FISHERY HARBOUR AT VELLAYIL, KERALA

Vellayil is situated at Calicut along the open coast at about 12 km north of Beypore, in Kozhikode District of Kerala. Fishing is one of the main sources of livelihood of the people of Vellayil. The fishermen are facing difficulties in berthing operation due to assailing waves from the Arabian sea. Harbour Engineering Division (HED), Government of Kerala has a proposal of development of fishery harbor at Vellayil & referred various studies to CWPRS. The Mathematical studies carried out in CWPRS for Wave Tranquility, shoreline changes, hydrodynamics and siltation inferred a suitable layout of the proposed fishing harbor at Vellayil. The recommended layout consists of a shore connected north breakwater of about 530 m length and a shore connected south breakwater of about 750 m length. Both the breakwaters are extended upto -4.0 m depth contours.

Based on the site specific data regarding bathymetry, wave conditions and tidal levels, conceptual design of breakwater were worked out using the empirical methods. The hydraulic stability tests were conducted in the 40 m long regular wave flume by reproducing the sections to a Geometrically Similar (GS) model scale of 1:28. Two alternative cross-sections at -4.0 m bed level for trunk as well as for the roundhead with 3 - 5 t stones & 4 t tetrapods in the armour at 1:2.5 armour slope have been suggested. Five different cross-sections with respect to various bed levels have been suggested. The sections were found stable upto a design breaking wave height of 4 m, hence were recommended for construction.Five different cross-sections with respect to various bed levels have been suggested. The sections were found stable upto a design breaking wave height of 4 m, hence were recommended for construction.



Layout of breakwaters



Wave flume test for breakwater

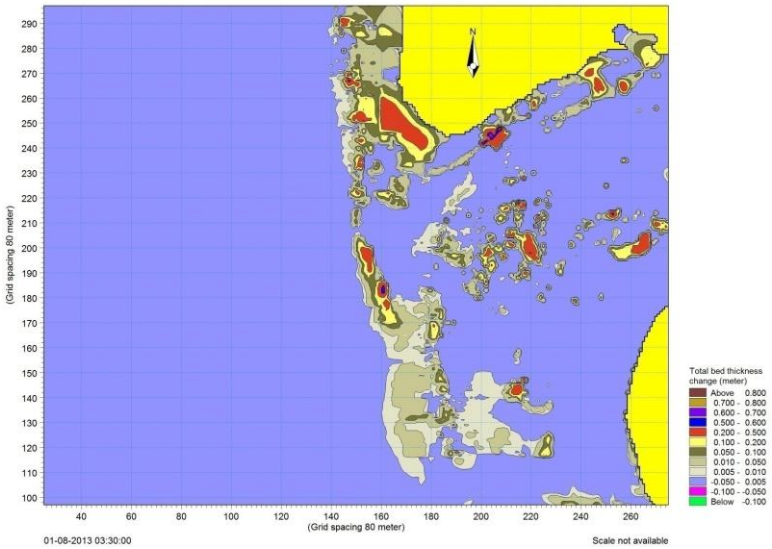
5167-MATHEMATICAL MODEL STUDIES FOR DEVELOPMENT OF COAL BERTH FACILITY AT DAHEJ, GUJARAT

Reliance Industries Limited (RELIANCE/RIL) intends to develop a 270 MW coal based thermal power plant at its Petrochemical complex Dahej inside Narmada Estuary. Location of Proposed Power Plant is inside RIL at Dahej. The power plant required 3.0 MMTPA coal which is to be imported through sea route and brought to the Plant. Presently, RIL is not having any coal handling facilities at Dahej or any nearby places. Therefore in order to develop develop suitable captive Marine facilities at Dahej to receive this 3.0 MMTPA Coal, RIL has requested CWPRS to carryout mathematical model studies for ascertaining the feasibility of developing marine facilities at Hazira.

These studies were conducted using MIKE 21 (HD) and sediment transport models. Using the information about the recent bathymetry, the hydraulic parameters like tides, currents, the velocity field and silt concentration, hydrodynamic model was initially simulated and calibrated. The model thus calibrated for existing conditions was used to study the proposed two options. Option I consisting of the desired dredging of basin at RDMT Jetty having a Length of 300m and width of 300m with a depth of -5.0m and Option II by incorporating an additional channel connecting outer sea with the RDMT Jetty basin having a width of 150m and depth of -5.0m.

From the hydrodynamic studies it can be concluded that the flow field is conducive with both the Options without undesirable significant circulation. But from natural depths availability Option I may be preferred. Subsequently, sediment transport model was run for estimation of sedimentation pattern for the proposed condition.

Sedimentation studies reveal that with natural channel Option I is more preferable as the capital dredging (1.0 m cum) and maintenance dredging (0.5 m cum) relatively is less. Water depth profile analysis was also conducted which suggests that barges can be operated using tidal window with proper time management of barge movement with Option I.



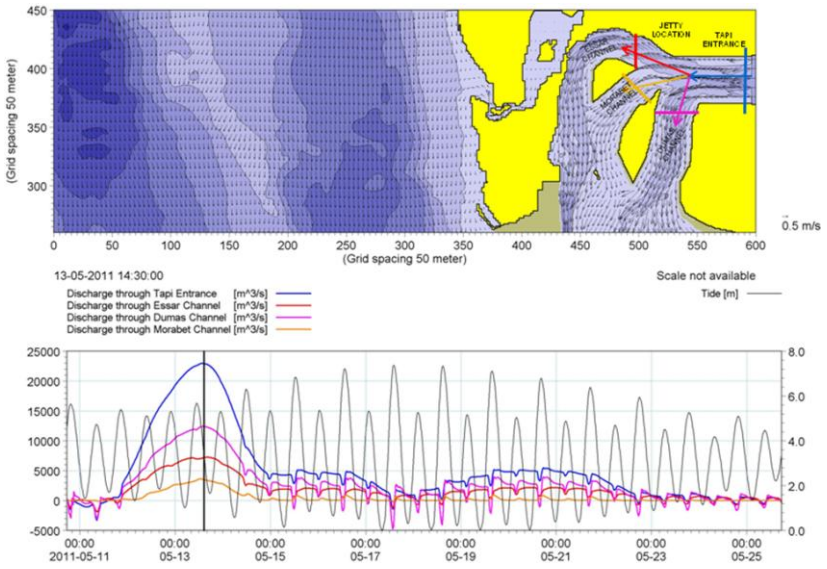
Sedimentation pattern with Option II

5168-MATHEMATICAL MODEL STUDIES FOR DEVELOPMENT OF COAL BERTH FACILITY AT HAZIRA, GUJARAT

Reliance Industries Limited (RELIANCE/RIL) intends to develop a 360 MW coal based thermal power plant at its Petrochemical complex Hazira inside Tapi Estuary. Location of Proposed Power Plant is inside RELIANCE at Hazira where a Triangular plot is earmarked. The power plant requires 3.0 MMTPA coal which is to be imported through sea route and brought to the Plant. Presently, RELIANCE is not having any coal handling facilities at Hazira or any nearby places. Hence, RIL approached CWPRS for carrying out model studies to suggest suitable captive Marine facilities at Hazira to receive this 3.0 MMTPA Coal.

The studies were carried out to predict the probable zone of siltation and zone of erosion and to arrive at suitable navigational channel with reasonable navigational depth considering tidal window and siltation aspects. Mathematical model studies for Hydrodynamics and sedimentation were carried out at CWPRS for the proposed coal berth facility considering both the existing and proposed developments, using MIKE 21 (HD) and sediment transport models. Mathematical model was initially simulated and calibrated using the available information viz. bathymetry, tides, currents and the velocity field. Further, Experiments with flood hydrographs was conducted in the model with a flood discharge of 23000 Cumecs at the Tapi River mouth into the estuary system and the results were analyzed to check the changes in the water level. Two possible navigational routes were identified initially are through buoyed channel and other through Dumas Channel and were analyzed for siltation pattern and water depth availability.

From the hydrodynamic studies it can be concluded that the flow field is conducive for both the channel Routes without any significant circulation. However, sedimentation studies reveal that with natural or dredged channel Route-I would be most preferable due to less capital dredging (7.5 m.cum) and maintenance dredging (2.2 M. cum) water depth profile analysis also suggest that barings can be operated using tidal window along Route I. Tidal window analysis for Barge movement indicates that the tidal window available for barge movement will be about 5 ½ hours.

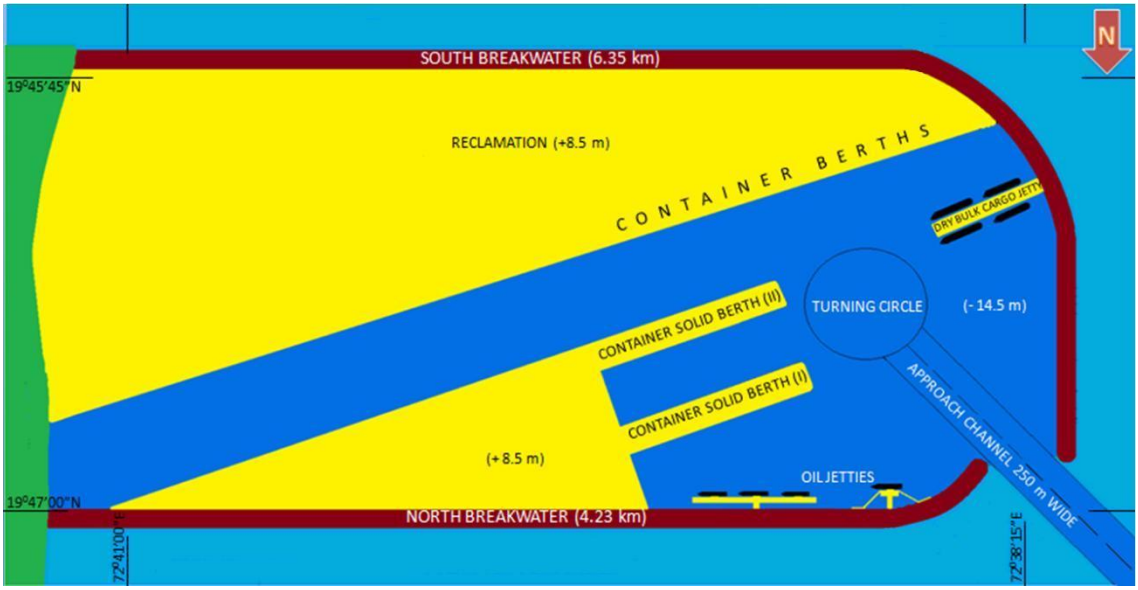


Discharge profile (23000 cumecs) through Essar, Dumas & Morabet channels

5169 -WAVE TRANQUILITY STUDIES FOR DEVELOPMENT OF ALL WEATHER CAPTIVE PORT FACILITY AT VILLAGE NANDGAON, PALGHAR TALUKA, THANE DISTRICT, MAHARASHTRA

Maharashtra Maritime Board (MMB), Mumbai and JSW Infrastructure Ltd (JSWIL) have a proposal for development of all weather captive port at village Nandgaon, Tal- Palghar, Dist-Thane, situated on the west coast of India at longitude $72^0$41′ E and latitude $19^0$46′ N. Location of proposed port is about 100 km north of Mumbai and south of the Tarapur nuclear power plant. The port facilities would include container berths, dry bulk cargo berths and oil jetties. In all, total 26 berths are planned to be developed in a phased manner with expected annual traffic of about 100 MT. The original layout of the port suggested by the MMB comprised 4.23 km long northern breakwater and a 6.345 km long southern breakwater with 250 m wide approach channel aligned at 315^0 N bearing. The dredged depth inside the approach channel, turning circle and basin is proposed as (-) 14.5 m.

The physical wave model studies were conducted at geometric similar (G.S.) 1:150 scale using random sea wave spectrums for the most critical incident wave directions corresponding to the monsoon and non-monsoon season. The permissible wave tranquility limit has been considered as 0.50m for the container ships and 0.90m at the dry bulk cargo jetties located on the lee side of the south breakwater. A modified layout and other alternate layouts for phasing the construction of project were tested in the model. The main findings of these studies for the original layout were that the north face of Solid Container Berth-I was expected to lose about 11 working days on account of high wave disturbance. It was recommended to provide sloping face for a critical length of about 1.0 km identified on the basis of the model studies along reclamation face for container berths for achieving adequate tranquility. The model studies were also conducted with full removal of north breakwater and only with container berths along the reclamation face in operation corresponding to the first stage of development and the loss of working days was estimated. The comparison of different layouts studied for Nandgaon port development in respect of the possible downtime periods was done which would enable project authorities to choose optimum layout during different stages of the development.



Original Layout of Master Development Plan for Port facilities at Nandgaon Village, Maharashtra

FOUNDATION & STRUCTURES

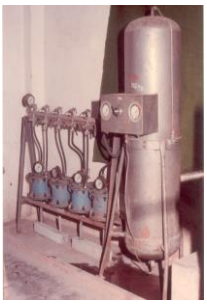
5060-PERMEABILITY OF CORES FROM UPSTREAM GUNITTING FACE OF DIMBHE DAM, MAHARASHTRA

The permeability of gunit refers to the amount of water migration through the gunit when water is under pressure or to the ability of concrete to resist penetration by water or other substances. It is a function of quality and relative proportion of gunit paste. Decreased permeability improves gunit resistance to resaturation, sulfate and chloride-ion penetration and other chemical attacks. Permeability increases with drying and reduces with age. Masonry dam surfaces are usually gunited to prevent ingress of water through masonry joints and weak zones. Gunitting also acts as a protection against wearing of surface due to environmental effects and attack of hazardous materials carried by water.

Dimbhe dam is a masonry dam built across river Ghod near Ambegaon in Pune district, Maharashtra. Height of the dam above lowest foundation level is 67.21 m and its length is 852 m. Upstream face of the dam is provided with gunitting to protect stone masonry from wearing and for barring entry of water through masonry joints. Seepage was observed through body of the dam and in the galleries. Quantity of water percolating through dam body was large and quite alarming. It was therefore, required to investigate the causes of seepage and to devise suitable remedial measures for arresting it. Studies, such as assessing quality of masonry by drilling cores, bore hole photography, non destructive testing, sonic logging and tracer techniques were undertaken. Before recommending any corrective measures, it was proposed to assess the quality of gunit cover on upstream face by extracting cores and testing for permeability.

Cores of 100 mm diameter were extracted from selected locations on upstream face of dam using a HILTI DD 350 portable core drilling machine. The minimum length of each core was about 200 mm. These cores were dressed to required size as per the standard practice to determine their permeability. Of the extracted cores, only 5 cores having sufficient length and sound in nature were selected for testing. Permeability of selected cores was determined using the permeability apparatus by the procedure as per IS-1727, IS-13645 & IS-3085 codes. The extracted cores indicated that the gunit cover is not uniform in thickness and varied from 10 mm to 625 mm. Also, permeability tests, though indicate that the gunit material is impermeable ($K < 10^{-12}$); cracks were observed in the gunit surface which are likely to promote ingress of water in the dam body.

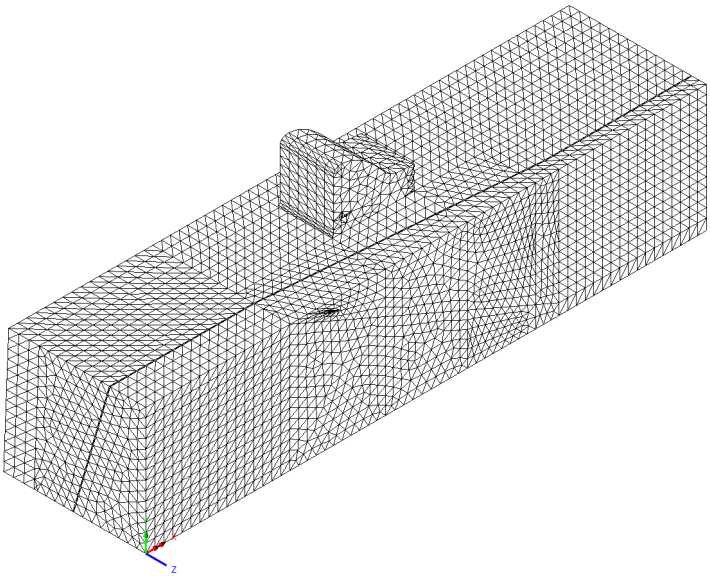
Extraction of cores



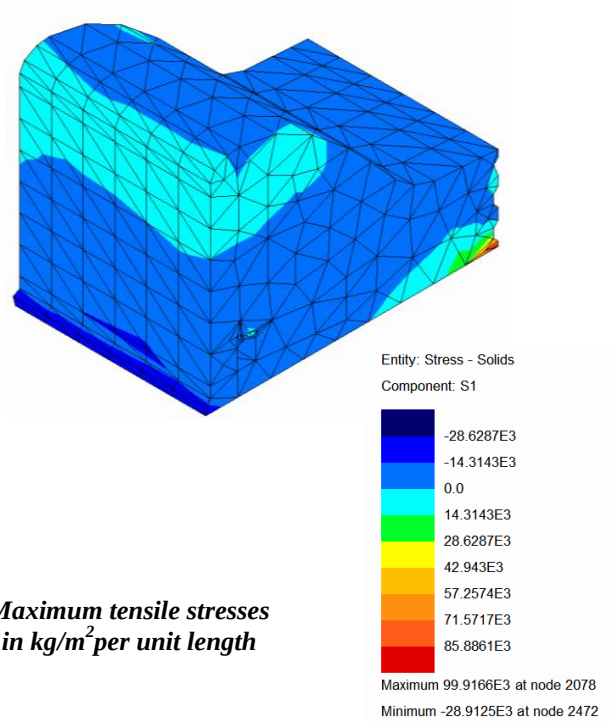
Extracted cores and Permeability test apparatus

5089-3D STRESS ANALYSIS BY FINITE ELEMENT METHOD OF MODIFIED SPILLWAY BLOCK No.18 INCORPORATING WEAK ZONES IN FOUNDATION FOR GARUDESHWAR WEIR, SARDAR SAROVAR NARMADA NIGAM LIMITED, VADODARA, GUJARAT

The proposed Garudeshwar Weir across river Narmada at 12.10 km downstream of Sardar Sarovar Dam near Vadodara, Gujarat, is a 1137m long concrete gravity structure comprising of 38 blocks. The weir will help to create a reservoir pool for enhancing power generation capability of Sardar Sarovar Power House during peak demand. In order to evaluate the tensile stresses and tension force distribution in the body of 23.75m high and 21 m long modified Overflow Block No.18 due to the effect of weak zones and dykes in foundation, 3D stress analysis has been carried out by FEM under various load combinations in accordance with IS 6512-1984, IS:1893-1984 and IS:1893-2002-Part I. The modified overflow Block No. 18 has been discretized with 1,02,042 four noded linear tetrahedral solid elements and 19,812 nodes after including all the details of openings such as seepage gallery and weak zones in foundation strata using LUSAS version 14.3 FEM software. Under static load combinations, the maximum tensile stress, of the order of 9.991E4 kg/m^2 per unit length, has been found to be developed in toe region for load combination 'F'. Under Earthquake load combinations including static loads, the maximum tensile stress of 3.146E4 kg/m^2 per unit length, has been found to have developed in the body of modified overflow block no.18 above foundation weak zones for load combination F. The maximum tension force in kg per unit length has also been estimated from tensile stresses above weak zones. The maximum (tensile) and minimum (compressive) stresses developed in modified overflow block no.18 for various load combinations including displacements have been found to remain within permissible limits.



3D mathematical model by FEM of modified overflow block 18 including weak zones and dyke in foundation



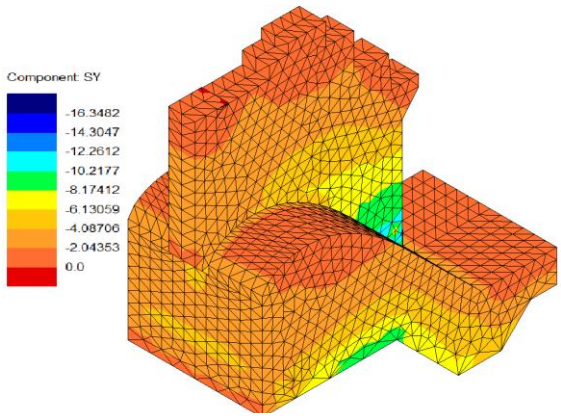
(+): Tension, (-): Compression

Maximum tensile stresses in kg/m^2 per unit length

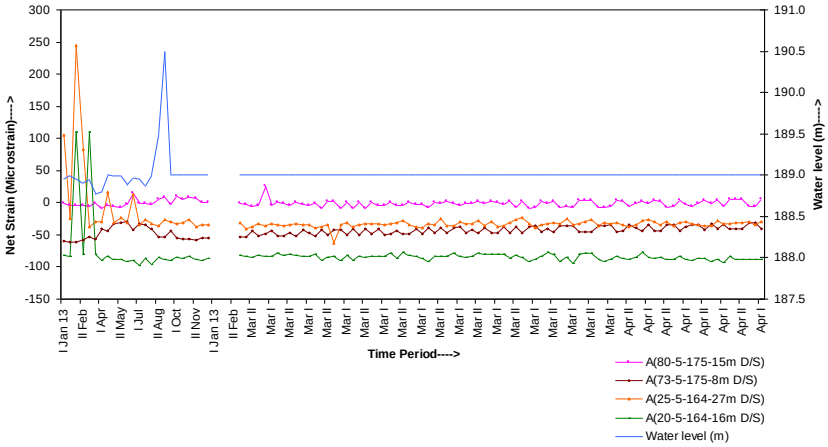
5100-ANALYSIS AND INTERPRETATION OF DAM INSTRUMENTATION DATA, OMKARESHWAR DAM, M. P.

53-meter high and 949 meter long Omkareshwar dam is a concrete gravity dam across river Narmada in Madhya Pradesh consisting of 27 blocks of which block nos. 5 to 26 form spillway portion. Besides irrigation, the dam further envisages power generation of 520 MW from installed 8 units of 65 MW each. In order to monitor the structural behaviour of dam, various instruments such as Bourdon type Gauges, Stress meters, Extensometers, Strain meters, No Stress Strain Meters, Pore pressure meters, Joint meters, Temperature meters etc. have been installed in Spillway Blocks and Power blocks at different levels and varying distances from dam axis by M/s AIMIL Ltd, Mumbai under the supervision of Jai Prakash Associates Ltd., Delhi. Data from installed instruments are collected by Project officials from time to time and sent to CWPRS for further studies. The studies include detailed analysis and plotting of data of various parameters along with reservoir water level Vs time, Stress analysis by FEM using LUSAS ver.14.3 software of dam block under various load combinations, interpretation of results and comparison with design / computed values in respect of all Spillway and Power blocks.

Present studies cover the results between Jan 2012 to April 2013. The pattern of measured pore pressure, relative deformations, Vertical Stress etc is erratic indicating malfunctioning of instruments. The vertical stress and displacement distributions have been obtained by carrying out three dimensional stress analysis by finite Element method as per BIS criteria.



Distribution of vertical stress (kg/cm^2)



Variation of horizontal strain in spillway block 5

5110-TEMPERATURE CONTROL STUDIES FOR NILWANDE DAM, MAHARASHTRA

Nilwande dam is under construction across river Pravara about 200 kms from Pune, Maharashtra. The dam was originally planned to be constructed using colgrout masonry. Accordingly colgrout masonry construction in overflow section was partly completed from EL 633.00 m to EL 641.50 m and Non Overflow section from RL 639/641 m to RL 652.00 m (base EL being 577m). It was decided to construct the remaining portion of the dam by using mass concrete. Two types of concrete mixes viz. M -15 and M - 20 were proposed for construction. In order to fulfill the design and strength requirements, the cement levels used for these two concrete mixes were 321 kg/m^3 and 364 kg/m^3 of concrete respectively. When such high levels of cement contents are used in mass concrete structures, it is imperative to study the thermal parameters of these mixes with a view to compare the induced tensile stresses due to heat of hydration with the strain capacity of concrete for given construction schedule. The project authorities therefore decided to estimate suitable placement temperature for the concrete mixes as a precautionary measure.

The computations and results are restricted to mass concrete mix M-15 as the maximum volume in the dam is comprised of this mix. The block width considered for computations is 15 m and average annual air temperature of the dam site is taken as 27.8 ^{0}C. The adiabatic temperature rise of concrete mixes is high and same is the rate of rise. This would require excessive cooling to meet the construction schedule. Considering small volume of concreting and as the core portion of Nilwande dam is constructed using masonry, the cooling arrangements like adding ice, pre-cooling of aggregates by inundation are avoided as far as possible. Some measures therefore suggested achieving the suitable placement temperature so that the placement temperature of concrete at batching plant shall be around 26^{0}C (and not more). These measures are: minimum time shall be elapsed between mixing and placing of concrete, lift height shall be limited to 1 m maximum, lift interval shall be minimum 168 hours, alternate lifts shall be constructed, aggregates directly from processor/ crusher shall not be used and these shall be stacked in covered sheds and stored avoiding exposure to direct sunlight for at least 3 to 4 days before use, the stacks of aggregates shall be continuously sprayed with water.

Nilwande dam construction in progress

Adiabatic Calorimeter with DAS

5122-DETERMINATION OF ROCK PROPERTIES AND STABILITY STUDIES FOR ROCK SLOPE AND EMBANKMENT AT TALABIRA-1 COAL MINE, ODISHA

Talabira-1 Open Pit Coal mine, of M/s Hindalco Industries Ltd., is located in the backwater area of Hirakud Dam in Sambalpur district, Odisha. The existing mine covers total area of about 170.305 Ha, measuring approximately 1300 m X 1350 m. Mining has been carried out to a depth of 54.5 m from RL 184.5 m to 130.0 m. There is a proposal to deepen the mine to a depth of 90.0 m, up to RL 94.5 m. An earthen embankment with Top RL 195.0 m prevents ingress of water from reservoir into the mine area. Studies to evaluate stability of embankment and rock slopes of the mine pit in existing and proposed mine areas were undertaken. Quantification of rock mass for slope stability analysis was done using Rock core properties which were determined from laboratory tests. The shear strength parameters, Cohesion (c) and Friction angle (ϕ) of the rock mass as determined by Rock Mass Rating (RMR) system of Bieniawski are 0.26 MPa and 31^0 respectively.

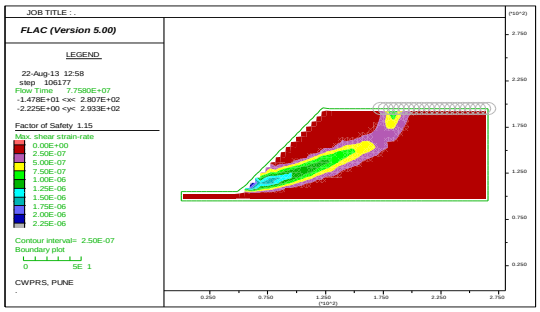
Stability of existing and proposed mine slopes was examined for steady seepage condition as well as for seismic loading condition using Geotechnical software FLAC–2D. Seepage analysis was carried out with FRL of 192.0 m. Since the site is situated in Seismic zone III of India, horizontal seismic acceleration of 0.08 g, was considered in Pseudo-static analysis. Stability analyses for following cases were studied:

I. Section with existing slope up to a depth of 54.5 m, from RL 184.5 to RL 130.0 m
II. Existing section with deepening to 90.0 m with slope of 1V:0.8H, up to RL 94.5 m.
III. Sections of 90.0 m depth, with different slopes from 1:0.5 to 1:1.4 for the proposed mine area. A slope of 1:0.8 was recommended.
IV. A section with steep slope angle of 60^0 from RL 184.5 m to 130.0 m (where coal seams are maximum), and a flatter slope angle of 45^0 from RL 130.0 m to 94.5 m, with a bench 6.0 m wide
V. Stability analysis of embankment slopes.

Factor of Safety of stability analysis are :

Case	Steady Seepage	Earthquake
I	3.10	2.39
II	2.05	1.64
III	1.32	1.15
IV	1.31	1.14
V	2.94	2.52

Mine slope monitoring with the help of instrumentation is recommended for monitoring warning signs of slope instability.

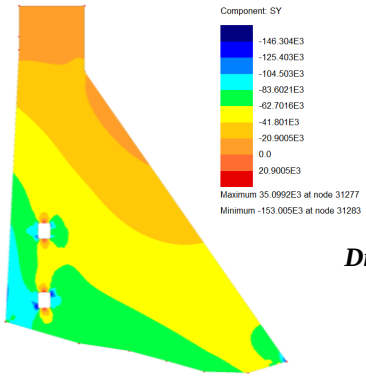


Probable zone of failure for slope of 1V:0.8H with seismic condition (Case III)

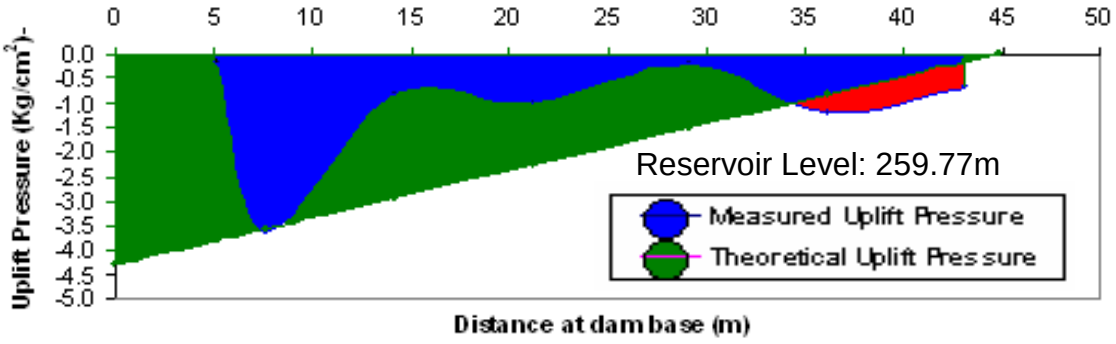
5123-ANALYSIS AND INTERPRETATION OF DAM INSTRUMENTATION DATA FOR PERIOD JANUARY 2012 TO DECEMBER 2012 FOR NON-OVERFLOW BLOCK 25, INDIRA SAGAR DAM, M.P.

92-meter high and 653 meter long Indira Sagar dam is a concrete gravity dam across river Narmada in Madhya Pradesh consisting of 27 blocks of which block nos 1 to 3 and 25 to 27 are non-overflow blocks while block nos. 4 to 24 form overflow (spillway) portion. Besides irrigation, the dam further envisages power generation of 1000 MW from installed 8 units of 125 MW each. In order to monitor the structural behaviour of dam, various instruments such as Foundation Piezometers, Uplift Pressure Pipes, Extensometers, Reservoir Water Level Meters, No Stress Strain Meters, Thermometers etc. have been installed in Non-Overflow Block No.25 at different levels and varying distances from dam axis by M/s Encardiorite Systems under the supervision of Instrumentation group, CWPRS, Pune. Data from installed instruments are collected by Project officials every fortnight since the year 2003 and sent to CWPRS at regular intervals for further studies. The studies include detailed analysis and plotting of data of various parameters along with reservoir water level Vs time, 2D Stress analysis by FEM, using Lusas ver.14.3 software, of dam block for various load combinations, interpretation of results and comparison with design / theoretical values and plotting of isotherms from installed thermometer data in respect of Non-Overflow block no. 25. Studies though primarily cover the results between Jan 2012 to Dec 2012, for the sake of continuity, monitoring behavior of instruments for the entire period between January 2003 to December 2011 has also been covered. The pattern of measured Vertical Stress, Displacement and Strain has been in fair agreement with theoretically computed values by FEM.

Measured uplift pressure exceeds theoretically computed values in downstream. For other parameters such as Temperature, water level and pore pressure, most of the instruments exhibited cyclic trend indicating regular dam behavior, remain within allowable limits and fairly match with theoretical values.



Distribution of vertical stress by 2D FEM



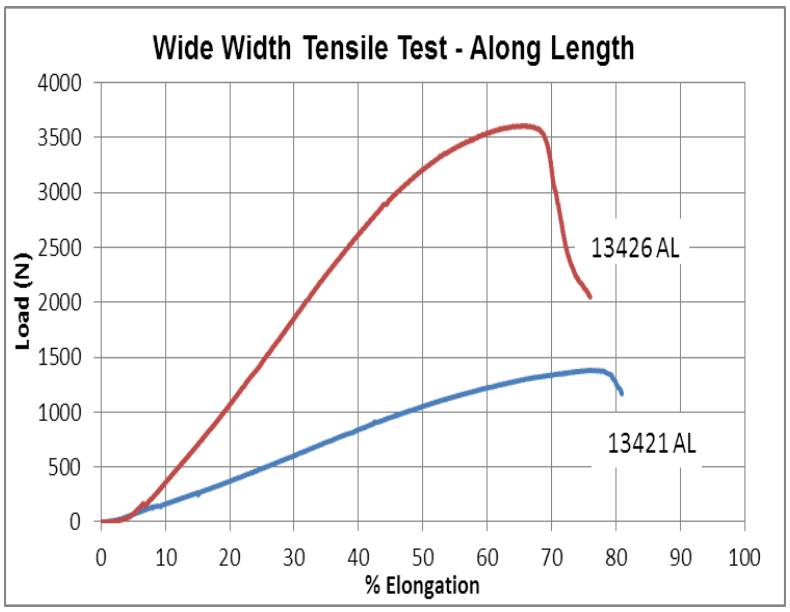
Comparison of measured and theoretical uplift pressure at dam base

5125-DETERMINATION OF GEOTEXTILE PROPERTIES OF GEOBAGS FROM WATER RESOURCES DEPARTMENT, SIWAN, BIHAR

Geobags are bags made up of geotextile material and filled with sand, gravel or lean concrete. Quality checks with respect to various properties of the geotextile material used for making of geobags are essential in view of their use in different applications involving construction of structures such as revetments, groynes, breakwaters, etc. Different laboratory tests which involve determination of various physical, mechanical and hydraulic properties are performed on the geotextile material of geobags to ascertain whether the material used conforms to the required specified values.

Geobags filled with sand are used for anti erosion work at various sites in Bihar by Water Resources Department (WRD), Patna. The Chief Engineer, Water Resources Department, Siwan, Bihar requested CWPRS to carry out tests of Geotextile material of Geobags in the geosynthetics laboratory of CWPRS. Laboratory tests were conducted on 38 Geobag samples of size 1.0 m X 0.7 m, as per ASTM standards. Properties of geotextile material such as i) Thickness, ii) Mass per unit area, iii) Apparent Opening Size (AOS), iv) Wide width tensile strength, v) Static puncture strength and vi) Trapezoidal tear strength were determined.

The test results indicated large variation in values. Thickness of geotextile material varied from 1.60 mm to 3.05 mm whereas Mass per unit area varied from 210 GSM to 442 GSM. The Wide Width tensile strength results were in the range of 6.68 kN/m to 20.78 kN/m and elongation reported was 30.26% to 102.9%. The Static Puncture strength values ranged from 1304.3 N to 2823.7 N. Trapezoidal Tear Strength results were in the range of 149.0 N to 417.7 N. It was recommended to compare the individual values of Test results, with that of the required test values, for ascertaining quality of each of the 38 geobags.



Graph of load vs. elongation in wide width tensile test on geotextiles

5126-STUDIES FOR DETERMINING IN-SITU PROPERTIES OF DAM CONCRETE, FOUNDATIONS MATERIALS AND ABUTMENT ROCK OF BHAKRA DAM AT NANGAL, PUNJAB

Bhakra Dam and its two contiguous Power Plants form the principal features of the overall Bhakra Nangal Project which in addition consists of Nangal Dam. Dam Safety Committee of Bhakra Beas Management Board during its inspection of 1990 has desired to carry out Dynamic Analysis of Bhakra Dam due to increase in seismic activities in Himalayan region.

Previous studies which were based on pseudo-static method were carried out in 1964, by Trial load Method. Further, in the year 1964, Finite Element Method for 2-D (ungrouted transverse joints) and 3-D (grouted transverse joints) conditions was used for reassessment of theoretical stresses and structural behavior (plumb line deflection) of the dam.

As such, dynamic analysis of the dam, besides a review of structural stability for normal static loading conditions, was to be carried out, by taking into consideration in-situ properties of materials (such as, rock and concrete moduli, etc). Different portions of the dam have been constructed with different concrete strength combinations.

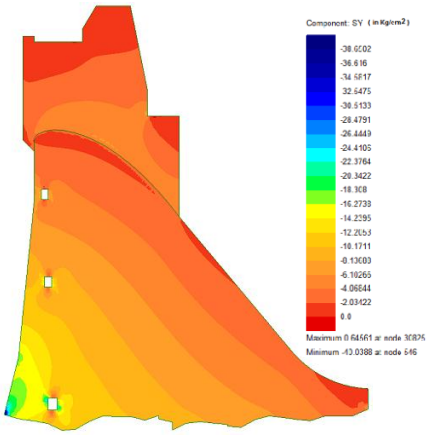
For determining realistic values of different constituents of the dam, the normal practice followed is laboratory testing of extracted concrete cores. But the Dam Safety Committee did not allow disturbing any part of the dam by extracting concrete cores throughout depth of concrete. So, in situ properties of dam concrete and surrounding rock mass are determined by flat jack method, which comes in the category of non-destructive test. The flat jack method is used to determine deformation modulus, cancellation pressure and Poisson's ratio. To quantify assessment of strength parameters of the vast strata of rock mass, the general approach adopted is Rock Mass classification system. The properties determined by Rock Mass classification system and flat jack test are found to be comparable. NX size rock and concrete cores upto depth of 50 cm are extracted by laboratory core drilling machine from the locations where flat jack tests are conducted. Cores are also extracted at eight locations in the galleries where flat jack tests were not conducted due to reinforcement in the surrounding area of galleries. The cores are tested in laboratory for determining various properties e.g. density,ρ, elastic modulus, E_L, Poisson's ratio,υ, unconfined compressive strength, σ_c, and Split tensile strength, σ_t.

The laboratory modulus values were correlated with modulus values determined by flat jack tests. Flat jack modulus values represent all the fissures/cracks developed in the mass concrete, so flat jack modulus values represent realistic elastic modulus, E_m, which is to be adopted for dynamic analysis. Average E_m for A1 concrete (mass concrete) is 17.38 GPa and 18.92 GPa for A3 concrete (0.91 m thickness surrounding of galleries). For B1 concrete 1.83 m thick on the upstream side of dam, E_m value can be adopted as 25.35 GPa. E_m of rock mass is 11 GPa, which can be adopted for analysis. The Friction angle of rock mass, ϕ is 34° and cohesion of rock mass, c is 0.27 MPa.

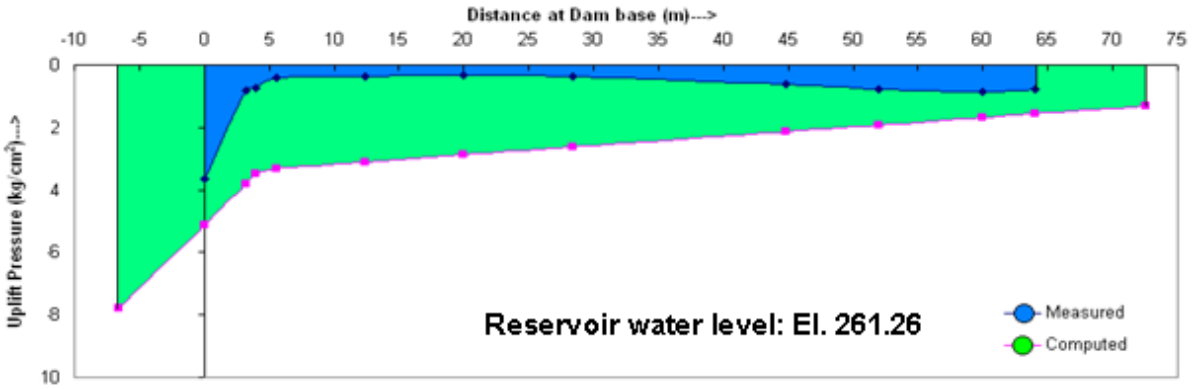
Average compressive strength, σ_c for A1 concrete is 33.90 MPa and 29.49 MPa for A3 concrete. Average σ_c for rock material is 71.87 MPa. Average tensile strength, σ_t for A1 and A3 concrete were 3.07 and 2.94 MPa respectively. Average σ_t for rock material was 3.54 MPa. Average Poisson's Ratio, υ for A1 and A3 concrete was 0.16 and 0.17 respectively. Average Poisson's Ratio, υ for rock was 0.14. The density of A1 and A3 concrete was determined as 2.27 and 2.28 gm/cc. Density for rock was found to be 2.61 gm/cc.

5149-ANALYSIS AND INTERPRETATION OF DAM INSTRUMENTATION DATA FOR PERIOD JANUARY 2012 TO DECEMBER 2012 FOR SPILLWAY BLOCK 13, INDIRA SAGAR DAM, M.P.

92-meter high and 653 meter long Indira Sagar dam is a concrete gravity dam across river Narmada in Madhya Pradesh consisting of 27 blocks of which block nos 1 to 3 and 25 to 27 are non-overflow blocks while block nos. 4 to 24 form spillway portion. Besides irrigation, the dam further envisages power generation of 1000 MW from installed 8 units of 125 MW each. In order to monitor the structural behaviour of dam, various instruments such as Foundation Piezometers, Stress meters, Extensometers, Reservoir Water Level Meter, Strain meters, No Stress Strain Meters, Thermometers etc. have been installed in Spillway Block No.13 at different levels and varying distances from dam axis by M/s Encardiorite Systems under the supervision of Instrumentation group, CWPRS, Pune. Data from installed instruments are collected by Project officials every fortnight since the year 2003 and sent to CWPRS at regular intervals for further studies. The studies include detailed analysis and plotting of data of various parameters along with reservoir water level Vs time, 2D Stress analysis by FEM, using LUSAS ver.14.3 software of dam block under various load combinations, interpretation of results and comparison with design / computed values and plotting of isotherms from installed thermometer data in respect of Spillway block no. 13. Studies though primarily cover the results between Jan 2012 to Dec 2012, for the sake of continuity monitoring behavior of instruments for the entire period between January 2003 to December 2012 has been covered. The pattern of measured Vertical Stress, Displacement and settlement has been in fair agreement with computed values by FEM. Measured uplift pressure remains less than the computed values as per BIS criteria. For other parameters such as Temperature, Water level and Pore pressure, most of the instruments exhibited cyclic trend indicating regular dam behavior, remained within allowable limits and fairly matched with computed values.



Distribution of vertical stress by 2D FEM



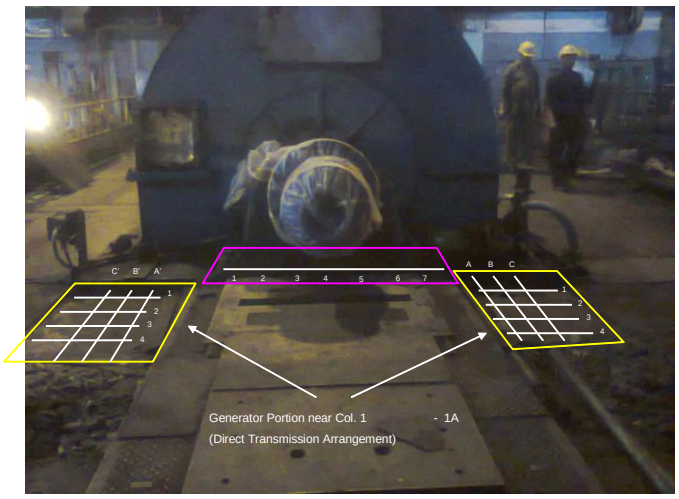
Comparison of measured and computed uplift pressure at dam base

APPLIED EARTH SCIENCES

5062-NON-DESTRUCTIVE STUDIES FOR ASSESSMENT OF QUALITY OF IN-SITU CONCRETE OF 25 MW T.A. FOUNDATION OF UNIT NO. 6, ROURKELA STEEL PLANT, SAIL (ODISHA)

The Captive Power Plant No.1 (CPP-1) consists of 5 × 25 MW of turbine units (Unit 1, 2, 3, 4 and 6), meets the power requirement of the Rourkela Steel Plant (RSP) for more than last 50 years. Recently, the RSP authorities have revamped the CPP-1 by replacing the old turbines by new ones, retaining their old frame type R.C.C. foundations and alternators. The foundation was constructed more than 50 years ago using 22.5 MPa grade concrete. In recent times, during operation of the TA Unit-6, excessive vibrations were felt. It was apprehended by the project authorities that deterioration in quality of the foundation concrete may be a cause of excessive vibrations. In order to ascertain the in-situ quality of foundation concrete, RSP authorities referred the studies to Central Water & Power Research Station, Pune. The present studies were undertaken with the turbine, alternator and other ancillary equipment maintained in their position, and hence only accessible portions of the foundation could be tested. Fig. shows the generator of the T.A. Unit No. 6 installed on the deck slab.

Ultrasonic pulse transmission technique was used for testing the foundation concrete. In order to cover maximum portion, 25 cm × 25 cm grid points were marked on opposite faces of all the 6 columns, 4 longitudinal and 2 transverse beams of the foundation. Travel times of elastic compressional waves were measured at more than 650 grid points covering maximum portion of the concrete. Knowing the distance of travel path and corresponding travel time, velocity of elastic compressional waves was estimated at each grid point. Portable Ultrasonic Non-destructive Digital Indicating Tester (PUNDIT) with 54 KHz transducers was used for measuring the travel times of elastic waves. In-situ quality of concrete was evaluated by comparing the observed velocities with the adopted velocity criteria and correlating compressional wave velocity with the quality of concrete. The studies indicated that the quality of in-situ concrete of all the foundation except transverse beam between columns 1 and 1A, embedded in the 1800 mm thick deck slab was inferred as good to very good. However, based on only limited observations taken on deck slab/ transverse beam, it has been concluded that a portion of about 2.1 m long and 1m thick of the concrete in deck slab/ transverse beam between the columns 1 and 1A, and close to the generator end may be graded as questionable to poor quality.



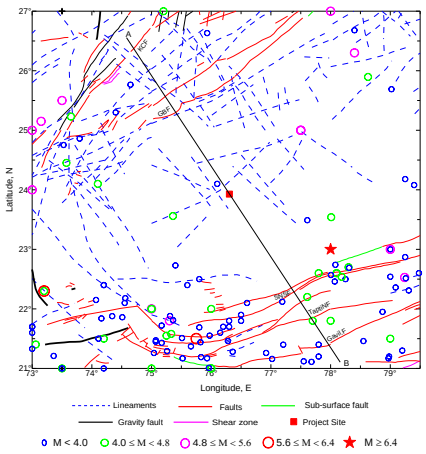
Photograph showing the generator of the TA Unit No. 6, installed on deck slab/ transverse beam between columns 1 and 1A

5063-ESTIMATION OF SITE–SPECIFIC SEISMIC DESIGN PARAMETERS FOR KUNDALIA MAJOR MULTIPURPOSE PROJECT, MADHYA PRADESH

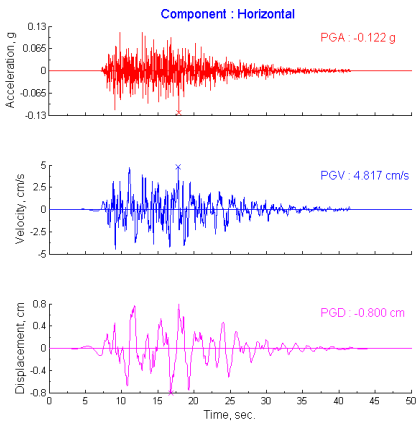
The Kundalia Major Multipurpose Project envisages construction of a 2355 m long composite dam having 44.5 m high concrete dam and 35.0 m high earthen dam across the river Kalisindh, the biggest tributary of the river Chambal. The site lies above the Son-Narmada-Tapti (SONATA) zone in a region of sparse seismicity in Zone II of the seismic zoning map of India (IS: 1893, Part-1, 2002).

Using regional data on tectonic features and associated seismicity, along with local geotechnical characteristics, site-specific seismic parameters had been estimated for earthquake resistant design of the various components of the project, using both deterministic and probabilistic approaches. The deterministic estimate was found to be governed by a maximum credible earthquake (MCE) of magnitude 6.0 on the nearest lineament at an epicentral distance of 16.4 km and focal depth of 15 km. The response spectra of horizontal and vertical components, with a confidence level of 50% and damping ratio of 5% for this earthquake provide the basic deterministic target spectra for generating the MCE level of ground motion. The probabilistic target spectra for MCE condition were computed with a confidence level of 96% by estimating the total expected seismicity in terms of the recurrence rate of earthquakes in different magnitude intervals for various seismic sources in the region. Since the difference between the deterministic and probabilistic spectral amplitudes was less than 25% for the periods of interest, the envelope of deterministic and probabilistic spectra had been recommended as a basis for the MCE level of design ground motion. For the DBE level of ground motion, the probabilistic spectra were obtained with a confidence level of 50% in 100 years and the deterministic spectra had been estimated with one standard deviation less than that of MCE. For DBE condition, the deterministic spectral amplitudes were seen to be higher than the probabilistic and were taken to be the DBE level of target response spectra.

The 5% damped target response spectra thus obtained, were used to generate the compatible accelerograms. The values of the peak ground accelerations for horizontal and vertical components of motion were found to be 0.122 g and 0.098 g, for MCE and 0.064 g and 0.051 g for DBE conditions respectively. The acceleration response spectra for damping ratios of 2%, 3%, 5%, 10% and 15% of critical were computed from the design accelerograms.



Correlation of the epicenters of past earthquakes with major tectonic features in the region of Kundalia project site



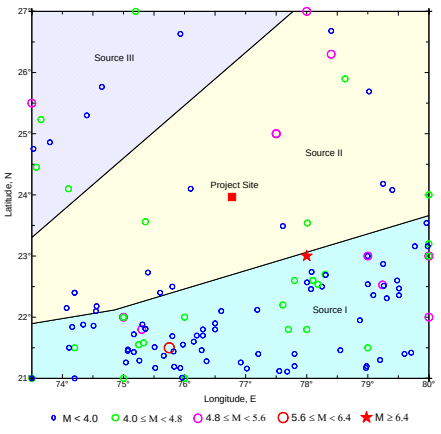
MCE level of design accelerogram and the computed velocity and displacement records for the horizontal component of ground motion

5064-ESTIMATION OF SITE–SPECIFIC SEISMIC DESIGN PARAMETERS FOR MOHANPURA MAJOR MULTIPURPOSE PROJECT, MADHYA PRADESH

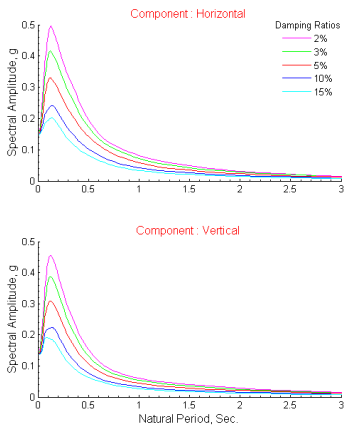
The Mohanpura Major Multipurpose Project, proposed on river Newaj in Rajgarh District of Madhya Pradesh, envisages the construction of a 2580 m long composite dam having 47.90 m high concrete dam and 35.71 m high earthen dam. The site lies above the Son-Narmada-Tapti (SONATA) zone in a region of sparse seismicity in Zone II of the seismic zoning map of India (IS: 1893, Part-1, 2002).

Using regional data on tectonic features and associated seismicity, along with local geotechnical characteristics, site-specific seismic parameters had been estimated for earthquake resistant design of the various components of the project, using both deterministic and probabilistic approaches. The deterministic estimate was found to be governed by a maximum credible earthquake (MCE) of magnitude 6.0 on the nearest lineament at an epicentral distance of 3.5 km and focal depth of 15 km. The response spectra of horizontal and vertical components, with a confidence level of 50 % and damping ratio of 5 % for this earthquake provide the basic deterministic target spectra for generating the MCE level of ground motion. The probabilistic target spectra for MCE condition are computed with a confidence level of 96% in 100 years by estimating the total expected seismicity in terms of the recurrence rate of earthquakes in different magnitude intervals for various seismic sources in the region. Since the difference between the deterministic and probabilistic spectral amplitudes was more than 25% for the periods of interest, the weighted average of the deterministic and probabilistic spectra with equal weights of 0.5 have been taken to be the target spectra for MCE level of horizontal and vertical components of ground motion. For the DBE level of ground motion, the probabilistic spectra were obtained with a confidence level of 50% in 100 years and the deterministic spectra have been estimated with one standard deviation less that that of MCE. For DBE condition, the deterministic spectral amplitudes are seen to be higher than the probabilistic spectral amplitudes and are taken to be the DBE level of target response spectra, since the site lies in Zone-II of the seismic zoning map of India.

The 5% damped target response spectra thus obtained, were used to generate the compatible accelerograms. The values of the peak ground accelerations for horizontal and vertical components of motion were found to be 0.131 g and 0.118 g, for MCE and 0.087 g and 0.077 g for DBE conditions respectively. The acceleration response spectra for damping ratios of 2%, 3%, 5%, 10% and 15% of critical are computed from the design accelerograms.



Seismic sources in the region of Mohanpura project site along with the epicenters of available data on past earthquakes

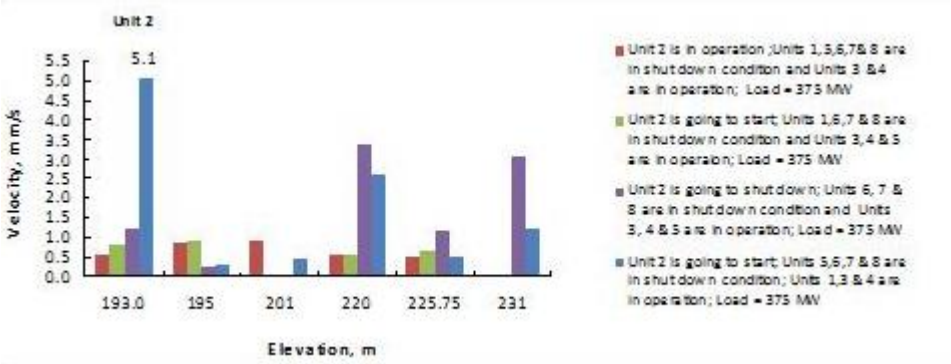


Design response spectra with damping ratios of 2%, 3%, 5%, 10% and 15% critical as computed from the MCE level of accelerograms for horizontal and vertical components of ground motion

5084-VIBRATION STUDIES FOR INDIRA SAGAR POWER STATION, INDIRA SAGAR PROJECT, NHDC LTD., KHANDWA, M.P.

Indira Sagar Project (ISP) located in Khandwa district of Madhya Pradesh across River Narmada is a multipurpose project with an installed capacity 1000 MW (8 × 125 MW). The power house with machine hall (202 m long, 23 m wide and 53 m high), service bay (42 m long, 23 m wide and 24 m high) and transformer yard (202 m long, 20 m wide) to house eight Francis type turbines of 125 MW each is situated on the right bank of the river. Vibration is one of the most undesired problems associated with operation of hydraulic machineries used for power generation. Such vibrations have potential to cause damage to surrounding structures. During the generation of electricity, structural vibrations are observed in the power house civil structures. It was apprehended that excessive vibrations may damage power house structure. With a view to assess the vibration levels experienced at the power house, simultaneous measurements were carried out on different floor levels. Vibration levels were measured in different running conditions of each of the eight turbine units such as all the eight units are in shut down condition, particular unit is running, is going to start and going to shut down. Tri-axial accelerometer with signal conditioners and PC based data acquisition system were used for measuring the vibration. At each location, vibration levels were measured in three mutually perpendicular directions; viz., longitudinal, vertical and transverse directions. The acceleration data were analysed to obtain the peak velocity and its associated predominant frequency. The peak velocities obtained from three mutually perpendicular directions were used to estimate the resultant velocity, which was compared with the available standards to assess their damage potential. The resultant velocity obtained for vibration measurement carried out for Unit-2.

Based on review of several vibration standards, for continuous long term vibration, 10 mm/s resultant peak velocity had been recommended as safe vibration limit for ISPS. The maximum vibration levels observed during field studies was 5.1 mm/s for Unit-2, which was about 50 % lower than the adopted safe vibration level indicating safety of power house structures against vibrations generated due to operation of turbines for generation of electricity at ISPS.



Histogram showing vibration level observed at different elevations of ISPS during various operating conditions for Unit-2

5088-MONITORING OF BLAST VIBRATION DURING CAPITAL DREDGING WORKS FOR CONSTRUCTION OF SECOND CHEMICAL BERTH AT PIR PAU, MUMBAI PORT TRUST, MUMBAI

Mumbai Port Trust (MbPT), Mumbai has proposed for the construction of a Second Chemical Berth (SCB), about 650 m south of the existing First Chemical Berth (FCB) at Pir Pau, Mumbai. The project will involve construction of a 300 m × 63 m berth pocket in front of SCB, widening and deepening of the existing approach channel and turning circle. The construction of the project will involve about 25,000 m^3 of hard rock dredging by pretreatment with underwater rock blasting. The rock formation at sites mainly consists of basalt with UCS varying from 16.04 MPa to 37.96 MPa and the depth of excavation will vary from 2 m to 3 m. The Elephanta Caves, a network of sculpted caves and recognized by the United Nations Educational, Scientific and Cultural Organizations (UNESCO) as a World Heritage Site is located about 2.6 km from the proposed site. It is apprehended that ground vibrations resulted from rock dredging may endanger the safety of Elephanta Caves as well as various civil structures located in FCB and Pir Pau Jetty. With a view to ensure safety of various structures against vibrations resulted from proposed underwater blasting, the Mumbai Port Trust authorities requested Central Water and Power Research Station (CWPRS), Pune to provide the guidelines for controlled blasting to complete the rock dredging work safely.

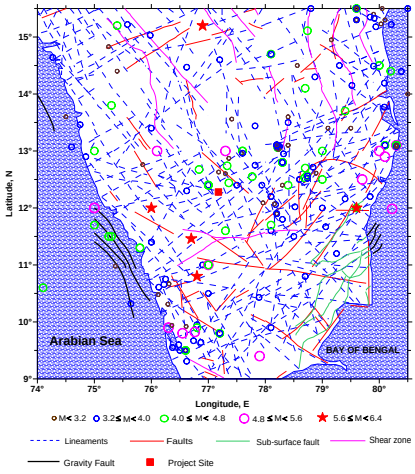
With a view to ensure safety of Elephanta caves and various civil structures located around the blasting site, peak particle velocity (PPV) of 1 mm/s and 10 mm/s, respectively was adopted as safe vibration levels. The preliminary safe charge weight for blasting was assessed from an attenuation relation developed using the ground vibration data recorded at different locations of Elephanta Caves in 1988 during underwater blasting of Nhava-Sheva Port, having basaltic type of rock formations. The entire area of excavation for the proposed SCB was divided into 21 different blocks and each block was subdivided with rectangular grid of 1.5 m × 2.8 m. 150 mm diameter holes drilled to the required depth with 1.5 m burden and 2.8 m spacing at each grid point was used for blasting. The blasting was carried out using KELVEX-P, CPT explosives with NONEL delay detonators and the maximum charge weight per delay used was 12.5 kg. All the blasts were monitored at the Elephanta caves as well as on different structures such as marine dolphin, pump house, fire station located at the existing Pir Pau Jetty using three components engineering seismographs. The vibration levels observed at Elephanta caves from these blasts are found to be well below 0.25 mm/s, the trigger level of the seismograph. The PPV levels observed on various civil structures, which vary from 0.96 mm/s to 2.98 mm/s were well below the adopted safe vibration level (10 mm/s). The use of small quantity of explosives confined in blast holes, non-electrical delay detonators and initiating each hole with a separate delay, helps in minimizing the ground vibration effects on surrounding structures. By following the suggested methodology of blasting, the capital dredging for construction of SCB for MbPT has been completed safely.

5091-ESTIMATION OF SITE-SPECIFIC SEISMIC DESIGN PARAMETERS FOR SHIVASAMUDRAM RUN OF THE RIVER POWER PROJECT, KARNATAKA

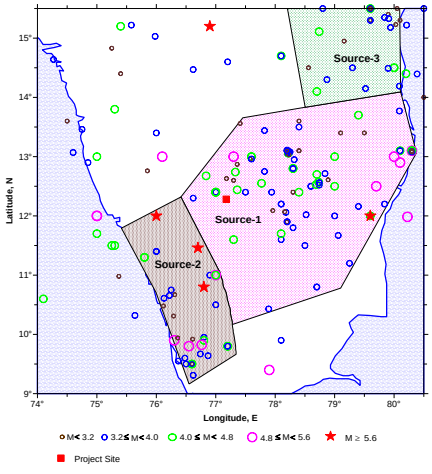
The Shivasamudram Run off the River Power Project (SRRPP) was proposed with a power generation capacity of 345 MW across Cauvery river in Karnataka State. The SRRPP site lies in the southern part of Peninsular India and the region of the site was characterized by occasional occurrence of earthquakes which are generally of small magnitude.

Using regional data on tectonic features and associated seismicity, along with local geotechnical characteristics, site-specific seismic parameters had been estimated for earthquake resistant design of the various components of the project, using both deterministic and probabilistic approaches. Since the deterministic spectra obtained for MCE magnitudes of 6.3 and 5.5 on the Arkavati Fault and the nearest Lineament respectively, had higher spectral amplitudes at different periods, the envelops of the two were taken to be the target deterministic spectra. The response spectra of horizontal and vertical components, with a confidence level of 50 % and damping ratio of 5 % for this earthquake provide the basic deterministic target spectra for generating the MCE level of ground motion. The probabilistic target spectra for MCE condition were computed with a confidence level of 96% by estimating the total expected seismicity in terms of the recurrence rate of earthquakes in different magnitude intervals for various seismic sources in the region. The envelops of deterministic and probabilistic spectra had been recommended as a basis for the MCE level of design ground motion. For the DBE level of ground motion, the probabilistic spectra are obtained with a confidence level of 50% in 100 years and the deterministic spectra had been estimated with one standard deviation less than that of MCE. For DBE the deterministic spectral amplitudes were seen to be higher than the probabilistic and were taken to be the DBE level of target response spectra.

The 5 % damped target response spectra thus obtained, were used to generate the compatible accelerograms. The values of the peak ground accelerations for horizontal and vertical components of motion were found to be 0.126 g and 0.110 g for MCE and 0.058 g and 0.052 g for DBE conditions respectively. Smoothed design response spectra were computed for damping ratios of 2 %, 3 %, 5 %, 10 % and 15 % of critical from these design accelerograms.



Correlation of the epicenters of past earthquakes with major tectonic features in the region of SRRPP site



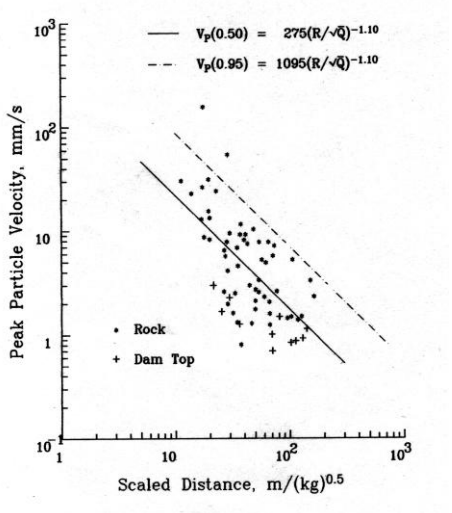
Seismic source zone in the region of SRRPP site along with the epicenters of available data on past earthquakes

5097-CONTROL BLAST STUDIES FOR EXCAVATION OF ROCK FOR YEDGAON H.E. PROJECT, PUNE, MAHARASHTRA

Yedgaon dam is a 4470 m long composite dam across river Kukadi in the Pune district of Maharashtra. Water from this dam was being released through the Kukadi Left Bank Canal (KLBC) for irrigation and drinking purposes. M/s Laxmi Organic Industries Ltd., proposed for construction of two units of Captive Power Plants (2× 1.5 MW) to generate 3 MW of power by utilizing the water released from the dam. The proposed project will involve large quantity of excavation of hard rock for construction of approach channel, intake well, water conveyor system comprising about 165 m long tunnel and about 60 m long open excavation, a power house and tail channel joining the Kukadi Left Bank canal. The rock formations at the project area consist of Deccan Traps basalt. The excavations are to be carried out close to the Yedgaon dam and several houses of the nearby village.

With a view to ensure safety of surrounding structures, methodology of control blasting was proposed for rock excavation. Resultant peak particle velocities of 25 mm/s and 10 mm/s are adopted as safe vibration levels for the Yeadgaon dam and village houses; respectively. A site-specific attenuation relation has been developed by recording ground vibration from thirteen experimental blasts conducted at the actual site of excavation. The blasts were made using 33 mm diameter jack hammer holes with depths varying from 1 m to 2.4 m. The holes were charged with 20 mm diameter cartridge explosive each weighing 0.125 kg and the maximum charge weights per delay varied from 0.125 kg to 2.75 kg. The blasts were detonated by using electrical ordinary detonators and non-electrical delay detonators. The ground vibrations generated from these blasts were recorded at various distances on rock and used for developing site-specific attenuation relation. Blast vibrations were also recorded on the Yedgaon dam as well as near by village houses. The observed vibration levels along with the site-specific attenuation relations are shown in Figure.

Site-specific attenuation relation with 95 % confidence level was used with adopted safe vibration levels for evaluating safe charge weight per delay for different distances. The safe charge weights thus estimated were used for design of safe blasting patterns and recommended for use in future for rock excavation. Line drilling method was recommended to minimize over excavation and damage to the surrounding rock mass. Periodical monitoring of blasts during actual excavation was recommended to ensure safety of structures and provide data to modify blasting patterns if required.



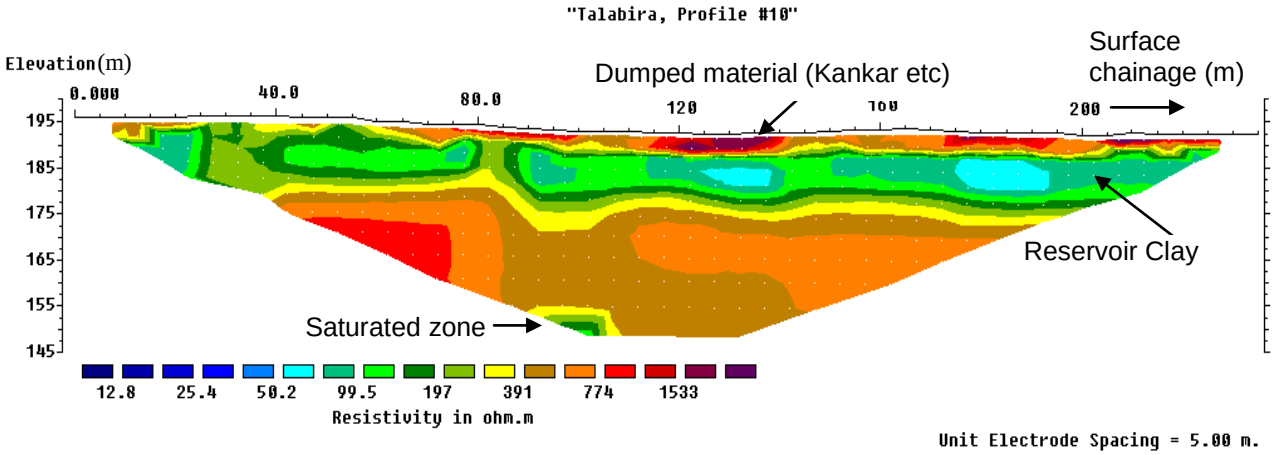
Site specific attenuation relations with observed vibration data

5109-ELECTRICAL RESISTIVITY IMAGING STUDY FOR DETECTING SEEPAGE AT TALABIRA-1 COAL MINE, ODISHA

Mining is being carried out at RL 137 m in Talabira-I open cast coal mine, Sambalpur district, Odisha, adjacent to the back waters of Hirakud reservoir on Mahanadi. The highest flood level of Hirakud reservoir is 192 m (RL) and the mining is expected to go deeper than the present level. Some seepage of water into the mine was observed from the high wall adjacent to the reservoir on the southern side. Electrical resistivity imaging survey was conducted along two lines parallel to the periphery outside the mine as well as along the haulage tracks within the mine to find potential seepage path in stratified and vulnerable reaches. A total of 13 Electrical resistivity imaging profiles were conducted out of which 3 profiles were along the haulage tracks in the existing mine and the remaining 10 profiles were taken outside the mine along the southern and western sides near the embankment.

Electrical resistivity imaging involves a series of resistivity measurements with different electrode spacing using a 2D multi electrode imaging system to control the measurements. The measured apparent resistivities are processed and interpreted to provide an image of true resistivity against depth. 'Schlumberger' array, with a large number of electrodes arranged in a linear array is employed and an automatic switching mechanism is used to select the relevant four electrode array for each measurement. Saturated zones are depicted as low resistivity anomalies in the imaging section.

The analysis of the resistivity imaging sections taken along parallel sets of lines revealed a few low resistive zones. These zones were correlated with coarse to fine shaly and gritty sandstone, broken shaly coal layers as reported in the boreholes situated near the profiles. One set of small sized satuarated zones occurring at about elevation 140 – 150 m with a resistivity range 50 – 200 ohm meters is found in parallel profiles P5 and P6 (in the reservoir area), P10 (along the southern periphery of the mine) and P1 (along the haulage road inside the mine). Another low resistive zone observed under profile P8 does not show any continuity either in parallel profiles P11 or P12. Thus, the low resistivie zones were attributed to satuaration and no significant seepage zone was found in the area covered by the study.

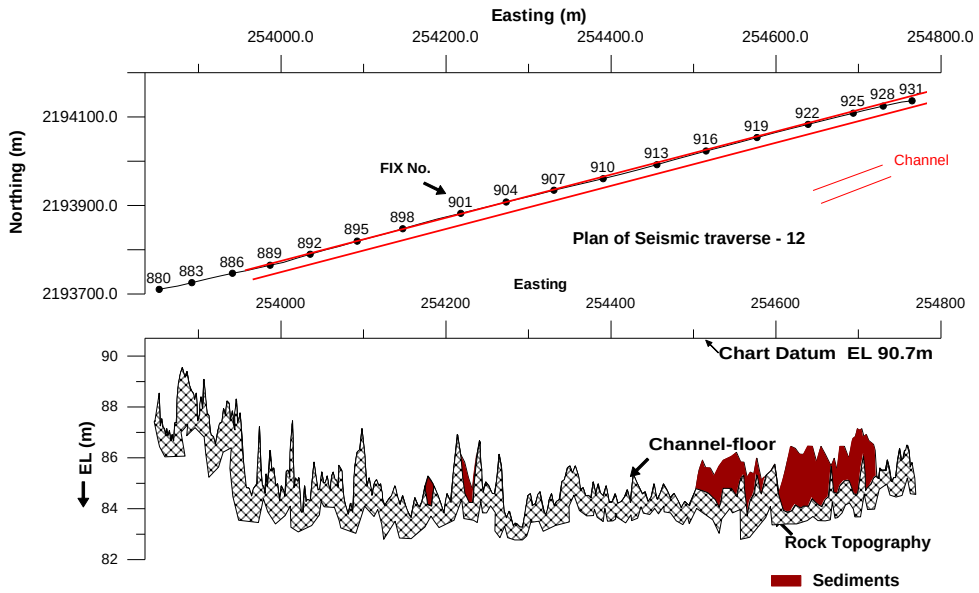


5111-UNDERWATER SEISMIC SURVEY FOR INTAKE CHANNEL (UNITS 3 & 4) OF TARAPUR ATOMIC POWER PROJECT, MAHARASHTRA

To meet the requirement of condenser cooling water for Tarapur Atomic Power Plant, units 3 & 4, a 800 m long, 20 m wide channel was dredged from Arabian sea to the intake pump. Due to increased water requirements and other variances such as site conditions, the intake channel was deepened by 1 to 1.5 m. To check the sea bed and sub bottom stratigraphy in the chanel, Underwater seismic reflection and Dual frequency echo sounder surveys were carried out in 2008 (CWPRS Technical Report no 4597 of Jan 2009). As the water discharge through the channel was not sufficient to meet the requirements, the intake channel was re-designed and further deepened by about 2 m from the earlier level.

To map the sea bed levels and sub bottom stratigraphy along the intake channel, Underwater seismic reflection and Dual frequency echo sounder surveys were again carried out along 12 traverses of lengths varying between 667 and 1007 m. Underwater seismic reflection data were acquired using 'X-star' chirp sonar system and 'SB-0512i' tow fish, using frequency band of 0.7 kHz – 12 kHz. 'Kongsberg' dual frequency echo-sounder with output frequencies 38 kHz and 200 kHz was used to measure the precise water depths. Position fixing and navigation of the survey vessel was conducted by deploying 'Sokkia' global positioning system with beacon receivers achieving position measuring accuracy of ± 2 m for the moving vessel.

The results revealed mainly the rock as the sea bed with a few pockets of sediments whose maximum thickness at a few locations was recorded up to 5.6 m. The level of rock with respect to chart datum (EL 90.7 m) inside the intake channel varied between EL 83.09 m and EL 88.12 m. In general, the depth to rock was lesser at the mouth of the channel near open sea as compared to the other portions of the intake channel.



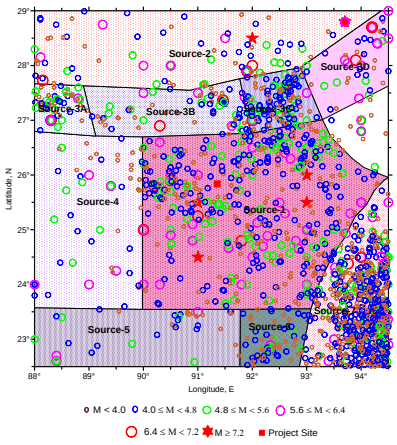
Depth Section along traverse- 12 (Fixes 880-931)

5113-ESTIMATION OF SITE-SPECIFIC SEISMIC DESIGN PARAMETERS FOR KULSI MULTI PURPOSE PROJECT, ASSAM

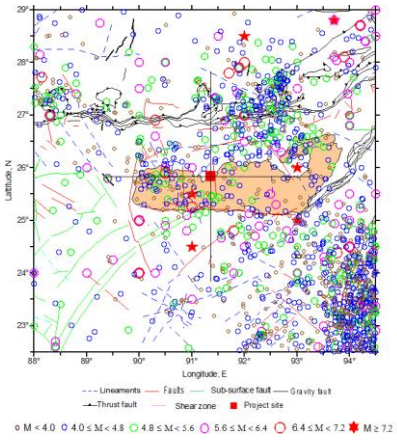
For detailed dynamic response analysis of important structures, the ground motion is required to be defined in terms of horizontal and vertical components of acceleration time histories. Hence, seismic hazard analysis is a prerequisite for the safe and economical design of important projects. Design spectra for different damping values are evaluated to obtain the seismic coefficients required for preliminary design. The 5% damped target response spectra are estimated using deterministic and probabilistic seismic hazard analysis approaches. The target spectra are then used to generate the compatible design accelerograms and design spectra. The Kulsi Multi Purpose Project (KMPP) was proposed on river Kulsi in Assam. The KMPP site falls in a high seismic tectonic province, which has experienced significant earthquakes in the past. The project site is located near the Kulsi Fault on the Shillong Plateau.

The deterministic spectrum of ground motion governed by the Maximum Credible Earthquake (MCE) magnitude of 8.0 and 6.5 on Dudhnoi and Kulsi faults respectively at different periods. Hence, the envelop of the two have been taken to be the deterministic target spectra. The target response spectra in the probabilistic approach are estimated by considering the effect of all the earthquakes with appropriate spatial distribution in the various source zones during a specified exposure period. For MCE condition, the probabilistic spectral amplitudes are obtained with a confidence level of 96 % in 100 years. For the Design Basis Earthquake (DBE) level of ground motion, the probabilistic spectra are obtained with a confidence level of 50% in 100 years and the deterministic spectra are taken to be either half of those of MCE or with one standard deviation less than that of MCE, whichever is higher. On comparing the deterministic and probabilistic target spectra, since the difference between the spectral amplitudes is more than 25% at the period of interest, the weighted average of the two, using equal weights of 0.5, had been taken to be the target spectra for both components of ground motion for MCE and DBE levels.

The 5 % damped target response spectra thus obtained, were used to generate the compatible accelerograms. The values of the peak ground accelerations for horizontal and vertical components of motion were found to be 0.467 g and 0.316 g for MCE condition and 0.234 g and 0.154 g for DBE condition respectively. Smoothed design response spectra were computed for damping ratios of 2 %, 3 %, 5 %, 10 % and 15 % of critical from these design accelerograms.



Seismic source zones in the region of KMPP site along with the epicenters of available data on past earthquakes



Correlation of the epicenters of the past earthquakes with major tectonic features in the region of KMPP

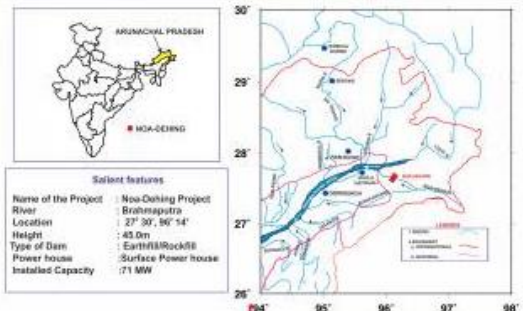
5114-ESTIMATION OF SITE-SPECIFIC SEISMIC DESIGN PARAMETERS FOR NOA-DEHING MULTI PURPOSE PROJECT, ARUNACHAL PRADESH

For detailed dynamic response analysis of important structures, the ground motion is required to be defined in terms of horizontal and vertical components of acceleration time histories. Hence, seismic hazard analysis is a prerequisite for the safe and economical design of important projects. Design spectra for different damping values are evaluated to obtain the seismic coefficients required for preliminary design. The 5% damped target response spectra are estimated using deterministic and probabilistic seismic hazard analysis approaches. The target spectra are then used to generate the compatible design accelerograms and design spectra. The Noa-Dehing Multi Purpose Project (NDMPP) envisages the construction of a 45 m high rockfill dam across Noa-Dehing River in Arunachal Pradesh. The NDMPP site falls in a high seismic tectonic province, which had experienced significant earthquakes in the past. The project site is located near the Naga thrust.

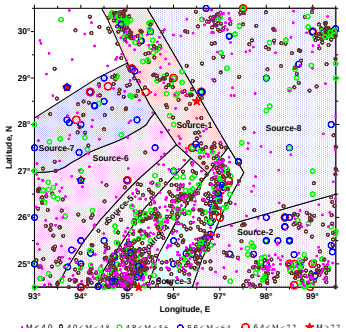
The deterministic spectra corresponding to Maximum Credible Earthquake (MCE) magnitudes 8.0 and 6.5 associated with the Mishmi and Naga thrusts respectively, were higher in different periods, hence, the envelop of two spectra have been taken to be the target spectrum. The target response spectra in the probabilistic approach were estimated by considering the effect of all the earthquakes with appropriate spatial distribution in the various source zones during a specified exposure period. For MCE condition, the probabilistic spectral amplitudes were obtained with a confidence level of 96 % in 100 years. For the Design Basis Earthquake (DBE) level of ground motion, the probabilistic spectra were obtained with a confidence level of 50% in 100 years and the deterministic spectra were taken to be either half of those of MCE or with one standard deviation less than that of MCE, which ever was higher.

On comparing the deterministic and probabilistic target spectra for DBE level the difference between the spectral amplitudes was seen to be more than 25% at the period of interest, hence, the weighted average of the two, using equal weights of 0.5, had been taken to be the target spectra. For MCE level the difference between the deterministic and the probabilistic spectral amplitudes was less than 25% at the period of interest hence, the envelop of the two spectra had been taken to be the target spectra.

The 5 % damped target response spectra thus obtained, were used to generate the compatible accelerograms. The values of the peak ground accelerations for horizontal and vertical components of motion were found to be 0.485 g and 0.306 g for MCE condition and 0.251 g and 0.129 g for DBE condition respectively. Smoothed design response spectra were computed for damping ratios of 2 %, 3 %, 5 %, 10 % and 15 % of critical from these design accelerograms.



Location and site plan of the proposed NDMPP, Arunachal Pradesh



Seismic source zones in the region of NDMPP site along with the epicenters of available data on past earthquakes

5115-SEISMIC TOMOGRAPHY STUDIES AT MANIKDOH DAM, KUKADI PROJECT, MAHARASHTRA

The 927 m long, 53 m high Manikdoh masonry dam on 'Kukadi' river in Junnar Taluka of Pune District was constructed in the year 1984, with a total storage capacity of 10.88 TMC. Subsequently to its impoundment, heavy leakage was observed through the masonry in both the galleries as well as in the downstream face of the dam. In view of this, the Dam Safety Review Panel committee, suggested seismic tomography of the structure to assess quality of the masonry and to delineate weak zones, if any, which are responsible for the seepage. Accordingly, seismic tomography survey was carried out along five horizontal and two vertical planes in May 2013 when the water level in the reservoir was low. The travel time data for tomography analysis was collected by placing geophones on the downstream face of the dam and hammer points on the upstream face of the dam. The seismic velocity distribution between each pair of source line and receiver line of the plane was computed using Simultaneous Iterative Reconstruction Technique (SIRT). The results of the study revealed a few low velocity zones with velocities less than 2500 m/s indicating inferior masonry quality between elevation 695 m to 705 m. Good quality masonry is indicated from elevation 685 m to 695 m. A prominent low velocity zone is found extending from elevation 695 m to 703 m from chainage 462 m to 469 m. The above observations indicated that the proper treatment of weak zones should be carried out to strengthen the masonry of the dam for reducing seepage.

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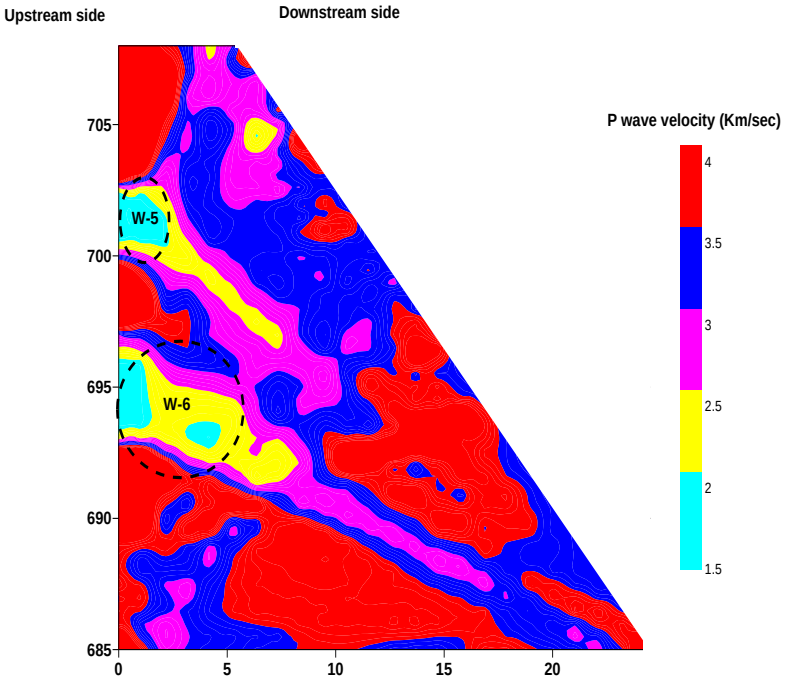
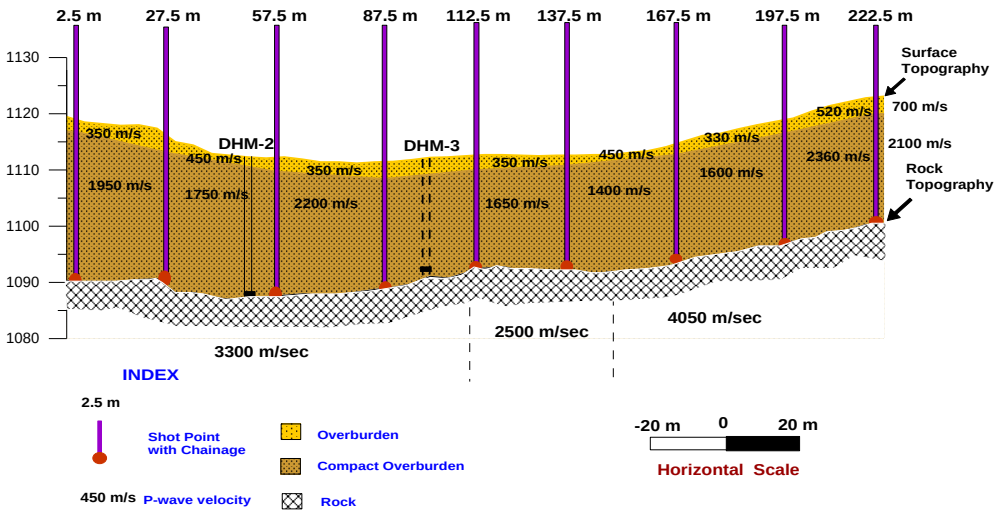


P- wave velocity distribution along vertical plane VP 2 at chainage 463 m

5132-SEISMIC REFRACTION SURVEY FOR PUNATSANGCHHU-I HYDROELECTRIC PROJECT, BHUTAN

The proposed 1200 MW Punasangchhu-I Hydroelectric Project near village Ruchekha in Wangdue Phodrang district of western Bhutan, envisages construction of a 130 m high concrete gravity dam across river Punatsangchhu. During the construction activity of the dam, extensive failure of the slope, subsidence and sliding were observed on the right abutment of the dam from 150 m upstream to 140 m downstream of dam axis between elevation 1260 m and 1110 m presumably due to the presence of a shear zone. Seismic refraction survey was conducted for finding the depth of rock and shear zone at the proposed dam site on left and right banks, on river bed, National Highway, cable car bench and colony area. The rock type occurring at dam site is biotite rich quartzo-feldspathic gneiss.

Seismic refraction survey conducted along six traverses of lengths varying between 105 m and 225 m revealed that the subsurface in general comprises two/ three layers including rock. The subsurface layers depending on compressional wave velocity values were interpreted as overburden (velocity values ranging from 330 m/sec to 1050 m/sec), compact overburden (1100 m/sec to 2400 m/sec) and rock (above 3000 m/sec). From the results of the survey, it is inferred that rock depth varies from 2.0 m to 27.0 m and from 18.0 m to 26.0 m on the left and right banks of river respectively. In the left bank profile it is seen that rock is shallow towards upstream side and it goes up to 27 m deep towards downstream side. Along some traverses, situated on the right bank hill slopes, loose strata is delineated and because of limited spread length available, the depth to rock could not be found. The results of the survey on the right bank slopes indicate loose and unconsolidated strata up to the depth of investigation.

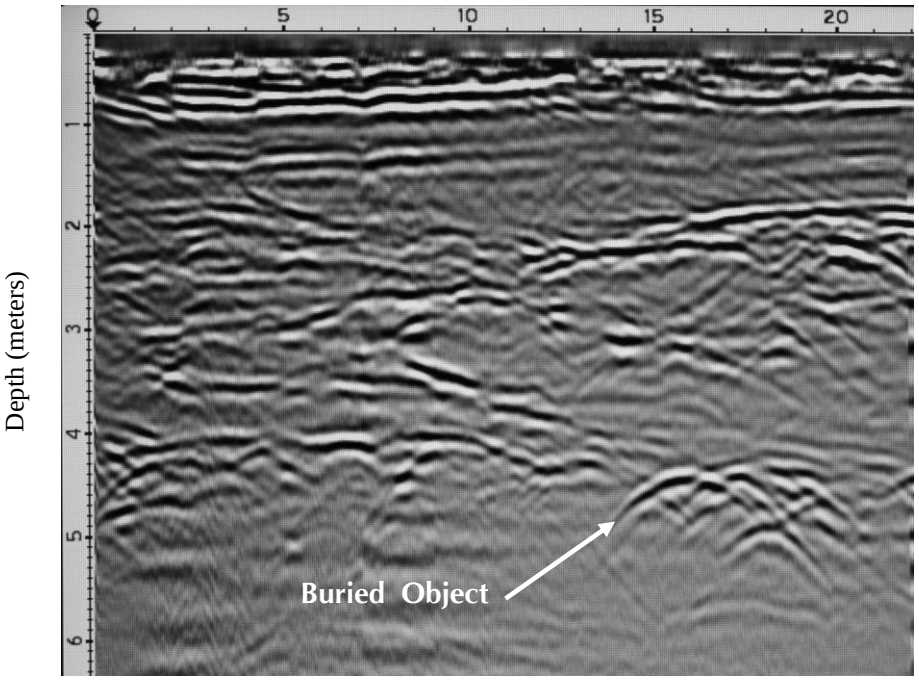


Seismic depth section along profile PR-1, Punatsangchhu H.E. Project, Bhutan

5133-GROUND PENETRATING RADAR (GPR) STUDIES IN THE D/S PORTION OF KOSI BARRAGE, BIHAR

A dredger deployed for extracting silt from the sand bar in the d/s of Kosi barrage opposite gate no. 28 encountered sudden floods during August 2011 and drifted about a kilometer and a half downstream. A small portion of the dredger was reportedly seen above the water table for nearly two to three months. It eventually disappeared and presumably got buried at the same location.

The area downstream of the Kosi Barrage constitutes the alluvial plain of the late Paleogene-Neogene times. The sand bars in the Kosi river are made up of sandy/silty layers and are saturated with fresh waters. A GPR survey around the supposed location of the buried dredger was conducted along 47 profiles of varying lengths in the N-S and E-W directions in five rectangular areas on a sand bar and two shoals downstream of Kosi barrage with a total length of about 14 km. GPR technique utilizes the propagation/reflection of electromagnetic energy into the ground to produce an image of the subsurface electrical conditions. Any object that is different in its electrical properties from the surrounding silt/sand shall stand out as an anomaly. 100 MHz and 250 MHz antennas were deployed for achieving the desired depth of penetration and resolution. The survey tracks were recorded with a global positioning system. In one of the profiles, the signature of a buried object different from that of the sand/silty layers was found at a depth of 4-5 m. The UTM coordinates of the location where the GPR signature was obtained were noted as 2932607 N and 492881 E and the spot marked on the ground with flags.

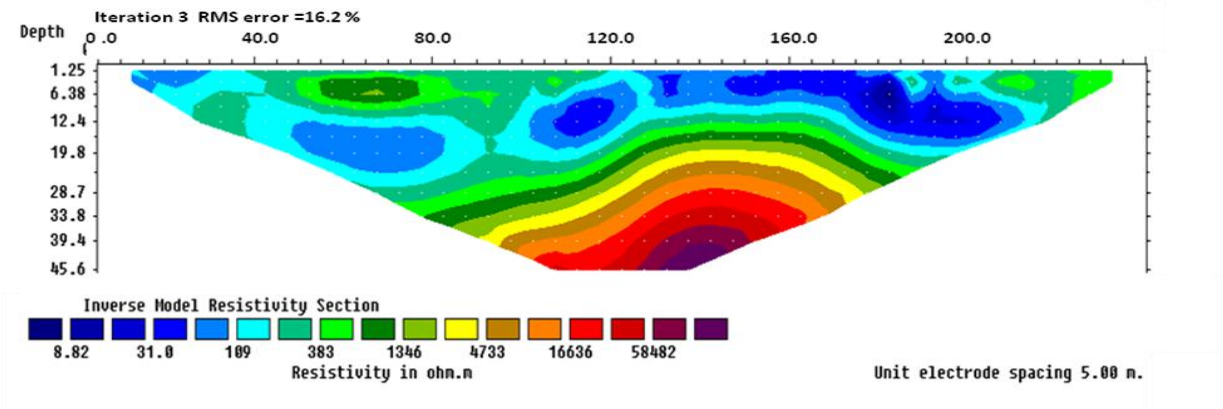


GPR record taken with 250 MHz antenna along Profile P-40 showing signature of buried object

5134-ELECTRICAL RESISTIVITY SURVEY AT PUNATSANGCHHU-I HYDROELECTRIC PROJECT, BHUTAN

The Punatsangchhu-I Hydroelectric Project is proposed to be developed for generation of 1200 MW of hydroelectric power. The project is situated near village Ruchekha in Wangdue Phodrang district of western Bhutan. The project includes a 130 m high concrete gravity dam across river Punatsangchhu. During the construction activity of the Punatsangchu-I dam, extensive failure of the slope has been observed on the right abutment of the dam from 150 m upstream to 140 m downstream of dam axis between elevations 1260 m to 1110 m. For finding depth to rock bed, fracture mass and extent of shear zone, four Electrical Resistivity Imaging profiles and six electrical resistivity soundings were undertaken at the proposed dam site on left and right bank of river bed, National Highway, cable car bench and colony areas. The rock type occurring at Punatsangchhu-I Dam site is biotite rich quartzo-feldspathic gneiss.

The electrical resistivity field data was analyzed by using 'RESIS2D INV' and 'RESIST' software. The analysis of the resistivity Imaging sections revealed the shallowest rock depth of 18.5 m on the left bank and presence of isolated boulder at the depth of 7 m to 20 m on the right bank. These results matched remarkably well with the results of VES-1 and VES-2 conducted at left and right banks respectively and also with seismic traverses taken at the river bed. The results of VES-3, VES-4 and VES-5 taken at National Highway, cable car and colony road locations show lower resistivities throughout the depth of investigation indicating presence of loose strata. The results of VES-6 taken at the east side of the colony show high resistivity at a depth of 61.8 m to indicate the presence of rock.



Resistivity imaging section of Profile ERI-3 at left bank of river bed

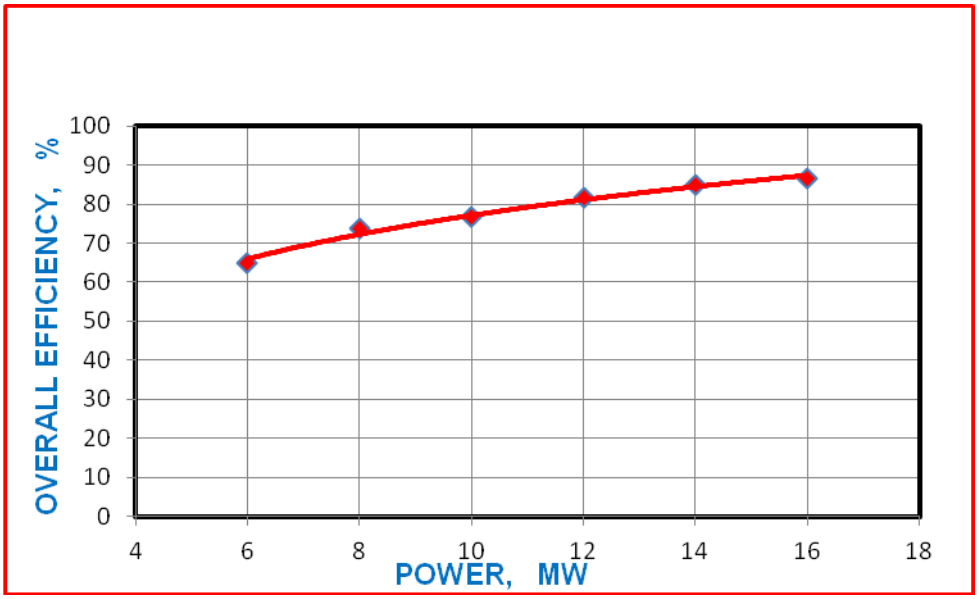
INSTRUMENTATION, CALIBRATION & TESTING FACILITY

5094-PERFORMANCE TESTS ON 16 MW KAPLAN TURBINE UNIT OF BHATGHAR HYDRO ELECTRIC PROJECT, MAHARASHTRA

Bhatghar Hydro Electric Project has a Kaplan turbine of capacity 16 MW situated at the downstream end of Yelawandi river, Maharashtra. Performance test was carried out to ascertain the efficiency of the machine running at varying load. This test was conducted at different water levels and data were analyzed. During test, flow rate was measured using clamp-on type ultrasonic flow meter installed on available accessible penstock portion near main inlet valve (MIV), head on turbine was obtained from the measurements of inlet pressure using pressure transducers, and the output power was taken from the Mega Watt (MW) meter installed in the central console of the Generations room.

It was observed during the field tests that the overall efficiency of the turbine at Full Reservoir Level (FRL) varied from 59.71% to 85.79% for load varying from 6 MW to 16MW. At design head, overall efficiency varied from 65.03% to 86.47% for load varying from 6 MW to 16 MW. During the tests at Minimum Draw Down Level (MDDL), overall turbine efficiency is found to be varying from 55.38 % to 74.77 % for load varying from 7 MW to 9 MW. At this level, there was a limitation for varying the load due to restriction imposed by the turbine on deduction of load.

From the series of tests carried out, it could be observed that the turbine unit is operating satisfactorily, however appreciable enhancement in overall efficiency is reasonable to be achieved for a refurbished turbine. It is recommended that the Project authorities maintain better hydraulic conditions at Penstock, Runner, Scroll casing and draft tube by taking up proper repair and refitting.



Efficiency versus load variation on turbine unit at Bhatghar H.E. Project

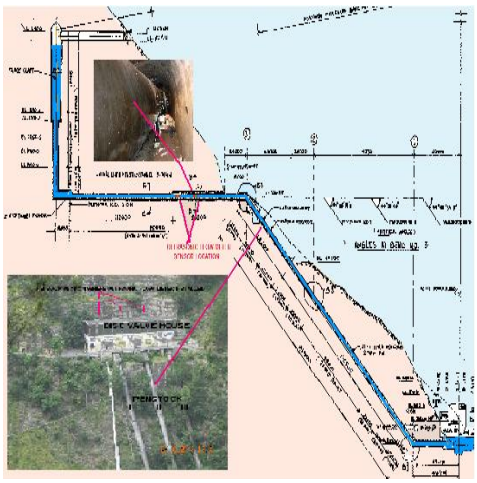
5148-HEAD LOSS TEST / FIELD MEASUREMENT IN WATER CONDUCTOR SYSTEM OF BAIRA-SIUL POWER STATION, HIMACHAL PRADESH

Baira Siul Power Station (BSPS) is located in Chamba district in Himachal Pradesh. The project was completed by NHPC in 1981, with install capacity of 180 MW. The power station utilises combined flow of three tributaries of the River Ravi namely Baira (Baira + Joiner), Bhaledh and Siul. The project comprises a 51 meter high rock fill dam across the Baira River. The dam diverts the water of Baira and Bhaledh River through intake structure to main HRT. The water flow through 7.63 Km long Horse Shoe shaped Head Race Tunnel. Further there is a 100 m deep (3 m diameter) Drop Shaft which supplement water from River Siul. BSPS has three 63 MW capacity Francis turbine units designed for operation on rated net head 260 m and minimum head of 250 m at rated discharge of 29 m^3 /sec. Accordingly the studies were undertaken for

- Measurements of head loss in water conductor system of Baira Siul Hydro Power Plant.
- Measurements of flow rate through penstock for different flow conditions in the turbine.
- Computation of net head on turbines based on CWPRS measurements.
- Computation of efficiency of turbine for full load conditions with different combination of operation based on CWPRS measurements

Head loss in the Headrace tunnel (HRT) was carried out with pressure transducer and float pulley arrangements, measured energy gradient at the selective locations of the water conductor system the value of Manning's 'n' in the headrace tunnel was found 0.015 -0.016 (MKS/SI system). Head loss of Penstock carried out with the measurement made in the penstock at Disc valve and MIV; the computed and extrapolated values of head loss and corresponding energy gradient extrapolated value of Manning's 'n' of the penstock was found 0.025-0.027 (MKS/SI system).

As the HRT and penstock friction values are higher and hence the thorough inspection of HRT and penstock shall be carried out and improvement shall be made to reduce the Manning's 'n' value .This may reduce the head loss and thus reduce water consumption. The discharge was measured in penstocks at one location for each turbine for various conditions and found from 24.2 to 28.08 m^3/sec. Due to heavy siltation, the working level of reservoir for power generation reduced to 3 m (instead of 9.15 m) i.e. EL 1113.00 m instead of EL 1119.00 m. Efforts should be made to restore the full working water level of reservoir for power generation.



Head loss test / field measurement in water conductor system

5151-HYDRAULIC PERFORMANCE AND OVERLOAD TESTS ON SUBMERSIBLE PUMPSETS FOR UTTAR PRADESH IRRIGATION DEPARTMENT

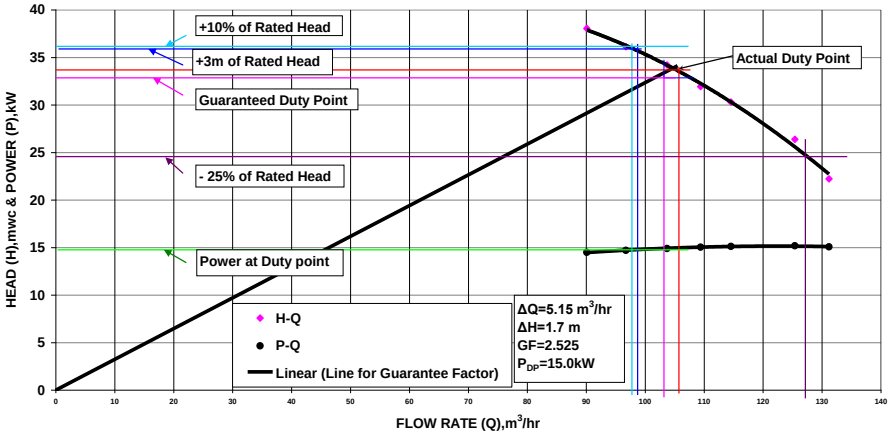
Hydraulic performance and overload tests were conducted at the request of Uttar Pradesh Irrigation Department (UPID), Lucknow for the submersible pump sets with 153 m^3/hr capacity, 18 m and 36 m head and 102 m^3/hr capacity, 18 m, 30 and 36 m head with squirrel cage Induction Motor of 26.1 KW, 15 KW and 11.2 KW, respectively. The tests carried out included:

- Variation of head, power input and overall efficiency against discharge covering a minimum range of + 10% to -15% of rated head from guaranteed duty point.
- Overall voltage and under voltage performance of motor of submersible pumps at 457 and 353 Volts, respectively.
- Power factor at rated output of motor.
- Temperatures rise of the submersible motor winding when the pump set was operated for an overload of 20%.
- Analysis of the experimental results by scaling the pump motor performance to standard frequency (50 Hz) and to ascertain the performance of the pump sets against guaranteed values

All the above tests were carried out in accordance with the stipulation of IS 9137-1978, IS 11346-1985, IS 325-1978, IS 8034-2002 and IS 10572-1983 (reaffirmed 1993). However uncertainty levels in the measurements were much better than IS stipulations, especially for the flow rate, input power and pressure measurement. Electrical parameters were observed precisely using a Multifunction Load Manager of Conserve make, having computer compatible digital output. Based on test results efficiency and guarantee factor-index that indicates the pump is working at its design head and discharge or above were evaluated as:

Pump Rating (Discharge, Head)	Efficiency(%)	Guarantee Factor	Power Factor	Temperature Rise
153 m^3/hr, 18m	64.40	1.040	0.788	20.449
153 m^3/hr, 36m	66.75	12.929	0.821	5.413
102 m^3/hr, 18 m	61.25	3.097	0.866	21.753
102 m^3/hr, 30 m	64.25	2.045	0.816	22.692
102 m^3/hr, 36 m	62.80	0.584	0.843	25.484
102 m^3/hr, 36 m (IInd sample)	62.15	1.962	0.822	21.341

It was recommended that in selection of the pump sets, importance be given to efficiency at duty point – head and discharge at which a pump is expected to be operated normally.



Performance (H-Q and power (P-H) curves for submersible pump of 102 m^3/hr at 33 m head

5155-HYDRAULIC PERFORMANCE AND OVERLOAD TESTS ON SUBMERSIBLE PUMPSETS OF 102 m^3/hr CAPACITY AT 18 M HEAD RATING

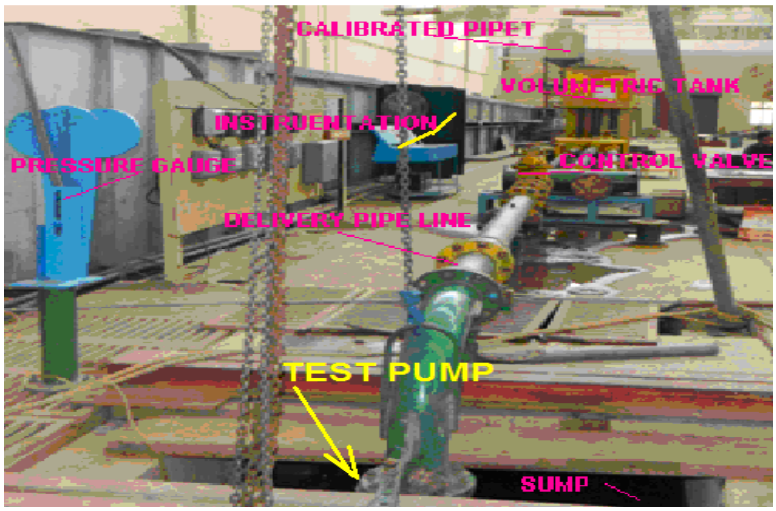
Hydraulic performance and overload tests were conducted at the request of M/s Rockwell Pumps and Motors Pvt. Ltd. Ghaziabad (UP) for the submersible pump sets with 102 m^3/hr discharge at 18 m head with squirrel cage Induction Motor of 11.2 KW. The tests carried out included:

- Variation of head, power input and overall efficiency against discharge covering a minimum range of + 10% to -15% of rated head from guaranteed duty point.
- Overall voltage and under voltage performance of motor of submersible pumps at 457 and 353 Volts, respectively.
- Power factor at rated output of motor.
- Temperatures rise of the submersible motor winding when the pump set was operated for an overload of 20% as well as when operated at 270 Volt for 2 Hrs. at duty point.
- Analysis of the experimental results by scaling the pump motor performance to standard frequency (50 Hz) and to ascertain the performance of the pump sets against guaranteed values

All the above tests were carried out in accordance with the stipulation of IS 9137-1978, IS 11346-1985, IS 325-1978, IS 8034-2002 and IS 10572-1983 (reaffirmed 1993). Based on test results efficiency and guarantee factor-index that indicates the pump is working at its design head and discharge was evaluated as:

Original design			Modified design		
Efficiency	Guarantee Factor	Input Power	Efficiency	Guarantee Factor	Input Power
61.7 %	0.753	17.6 kW	62.0%	1.962	17.0kW

It was suggested that during design of the pump sets, importance be given to Guarantee factor, efficiency at duty point – head discharge at which a pump is expected to be operated normally. The test results are plotted graphically to evaluate the guarantee factor, the guarantee factor above 1 is acceptable as per IS 9137-1978, IS 9283:1995 and. IS 11346-2002.



Submersible pump test rig in volumetric laboratory

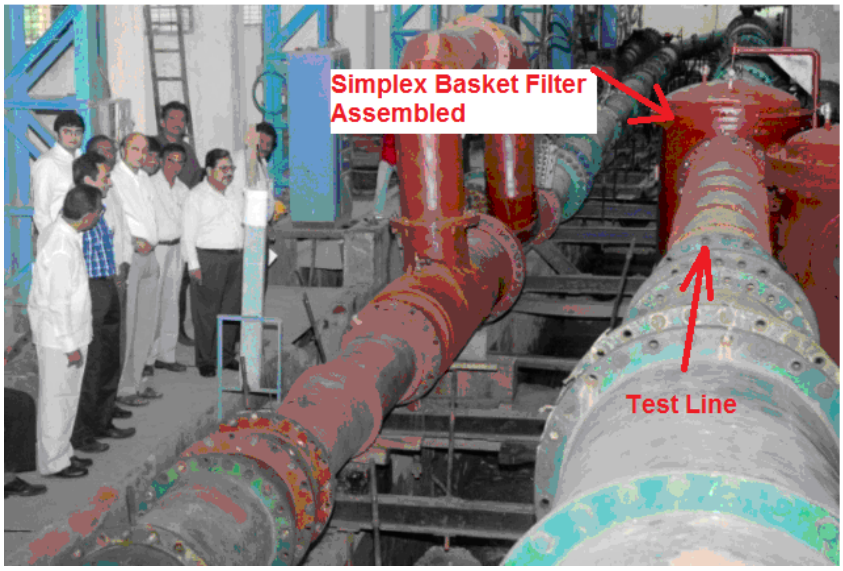
5163-PRESSURE DROP TEST ON FILTERS OF M/S FILTRATION ENGINEERS INDIA PVT. LTD; MUMBAI

Simplex basket filters of 500 mm NB, 450 mm NB and one duplex basket filter of 500 mm NB flange size with flow rates 1370 cum/hr, 1240 cum/hr and 1000 cum/hr respectively are being supplied by M/s Filteration Engineers India Pvt. Ltd; Mumbai, to National Thermal Power Corporation (NTPC) through Bharat Heavy Electrical Ltd. for installation at Bhartiya Rail, Bijali, Power Co. Ltd; Nabinagar. Since filters are used to remove any trash and floating material in the fluid being supplied for any specific application, the filter elements may get clogged in due course of time due to which the pressure loss across the filter increases.

M/s Filteration Engineers India Pvt. Ltd; Mumbai had referred to CWPRS to undertake tests on these three filters to assess head loss across each at their rated flow rates for different filter element conditions.

The filters to be tested for pressure drop was installed in high precision gravimetric calibration system installed at CWPRS, by providing sufficient straight length upstream of the filter. Pressure drop across the test filter at different flow rates was computed from the pressure measured across the filter. The flow rate was measured gravimetrically. The experiments were conducted for 100% clean condition and 50% clogged condition of the filter element's flow surface. Pressure drop curves were established for each filter for its 100% clean condition and 50% clogged condition. The pressure drop at rated flow rate measured for three filters for different filter conditions are indicated below:

Sr No	Type of Filter	Rated flow rate (m^3/hr)	Pressure drop (Kg/ cm^2)	
			With 100% clean Filter element surface	With 50% clogged Filter element surface
1	Simplex Filter Size 450 mm NB	1240 m^3/hr	0.100	0.110
2	Simplex Filter Size 500 mm NB	1370 m^3/hr	0.090	0.090
3	Duplex Filter Size 500 mm NB	1000 m^3/hr	0. 18	0.15



Simplex filter installed in gravimetric calibration test facility

CALIBRATION OF FLOWMETERS, TESTING OF FILTERS AND VALVES

Calibration of flow meters and water meters is essential for measurement of water transfer from supplying agencies to end users, interstate sharing of water, and flow through hydro turbines in hydropower sector, etc. Filters are used to remove the suspended particles in water to supply clean water for steam generation in thermal power plants, and are required to be tested for the pressure drop, which defines their efficiency. Valves are usually used to control the flow rate in any flow process system, and they are required to be tested to ascertain their head loss versus discharge characteristic. Effective utilization of ground water is possible with submersible pumps and hydraulic performance of these pumps is evaluated at HMC laboratory. Gravimetric and volumetric calibration facilities conforming to ISO 4185 are available at CWPRS for calibration of flow meters, testing of filters and ascertaining flow valve characteristics as detailed below:

Gravimetric Calibration facility	Volumetric Calibration facility
Maximum line size : 1000 mm NB (May be extended up to 1200 mm NB)	Maximum line size : 250 mm NB
Maximum flow rate : 7200 m3/hr	Maximum flow rate : 300 m3/hr
Calibration uncertainty : +/- 0.3 %	Calibration uncertainty : +/- 0.5 %
Capacity of tank : 100 tonnes	Capacity of tank : 3861.625 Liter

The principle employed in the gravimetric calibration facility is to accurately weigh the quantum of water passing through the flow meter under calibration at constant flow rate in a precisely known interval of time. The ratio of weight to time is the primary measure of flow rate against which the flow meter is calibrated. On the other hand, volume is measured in the volumetric calibration facility.

116 Flow meters were calibrated mainly for Endress+Hauser, Mumbai, Siemens (India) Pvt limited, Nivo Controls Ltd, Indore, Mather & Platt pumps Pvt Ltd, Pune, Kirloskar brothers Ltd, MIDC, BWSSB, Bangalore etc. Various types of valves were tested for KOSO India Pvt Ltd, Nashik. Hydraulic heavy duty filters/strainers have been tested for NTPC, BHEL, Toshiba Japan, KSB Germany, L&T, Gujarat Otofilt, Ashi Engineering Co, Filtration Engineers, Mumbai etc.

Field studies for efficiency and performance evaluation were undertaken on hydraulic turbines of Kopili HEP (NEEPCO) (275 MW), Field studies on flow measurements were carried out at NTPC Nashik and Hindalco Muri works respectively.

Main inlet valve of turbine at Kopili HEP

Head loss testing of heavy duty filter for NTPC

TESTING OF SAMPLES OF VARIOUS CONSTRUCTION MATERIALS

Geotechnical Engineering and Concrete Technology Divisions at CWPRS undertake testing of samples of soil, rock, concrete and masonry for determining various engineering properties. Soil and rock samples are generally tested for determining the properties like shear strength, consolidation characteristics, dynamic Young modulus, Poisson's ratio, tensile and compressive strengths, and cohesion and angle of friction. The concrete samples are tested for evaluation of strength, elastic, creep and thermal properties.

Equipments such as direct shear, triaxial shear, compaction, consolidation and resonant column are available for determining the soil properties. Rock samples are tested using equipments like triaxial cell, fully automatic compression testing machine, direct shear test equipment, deformation jackets, point load testing machine etc. Standard NX size (54 mm diameter) samples are tested by measuring stress and strains during loading/unloading. The rock properties are used for stability analysis of underground openings and design of foundations of structure. Concrete samples and repair material specimens are tested using 60 Tonne universal testing machine and 200 Tonnes compressive testing machine for determining strength and elastic properties. The concrete properties are used in assessing quality of concrete and masonry structures and strengthening/ rehabilitation of major hydraulic structures. Further temperature control studies on mass concrete mixes are carried out using in house developed facilities for estimation of suitable placement temperature.

A total of 26 soil, 193 Geosynthetics, 309 rock and 554 concrete samples were tested during the year for various project sites of Uttarakhand Jal Vidyut Nigam Ltd., Steel Authority of India Ltd., Talabira Coal Mines of M/s Hindalco Ltd, Odisha and State Governments of Maharashtra, Rajasthan, Karnataka, Madhya Pradesh, Tamil Nadu, Kerala, Bihar, Goa etc.

Triaxial test equipment for soil

Fully automatic compression testing machine

WATER QUALITY ANALYSIS AND MODELING

A study on significant trends in the water quality of Khadakwasla reservoir (2003-2012) was carried out through 54 field studies and laboratory analysis. Results were analysed and technical report was submitted during February 2014. Some of the observations show the overall rising trend in conductivity. Progressive increase in planktonic primary productivity (PP) indicates the vulnerability of the reservoir for the eutrophication. Spatial difference in species-composition was more prominent during winter and minimum during monsoon. CCME – Water Quality Index, computed by considering observations of 19 water quality parameters, remained between 81 to 91 showing 'good' quality. The spatial and seasonal differences are attributed to the combined effects of various hydrological and physico-chemical factors in the reservoir and human activity on banks.

The laboratory of Water Quality Analysis and Modelling (WQAM) division is well equipped with modern equipments like Soil and Water Analysis Kit (SWAK), Water Quality Monitor(WQM), EC-pH-Turbidity meters, Flame Photometer, UV-Visible Spectrophotometer, Atomic Absorption Spectrophotometer(AAS), Carl Zeiss Compound Microscope and OLYMPUS Stereo Zoom Microscope with camera attachment. MIKE21 software is used for simulating the integrated hydrodynamic and water quality scenarios for reservoirs under different conditions of development and pollution.

Physico-chemical parameters such as electrical conductivity, pH, temperature, Secchi depth, turbidity, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), nutrients and inorganic cations-anions including heavy metals and biological parameters like primary productivity, plankton composition, density and diversity of water are analysed in-situ and in laboratory to know the status of water body. The analysis reports are useful to provide the decision-support for a range of projects dealing with allocation of reservoir water for various purposes and their suitability for respective designated use.

During the current year a total of 508 water samples and 21 soil/concrete/aggregate samples were analysed for various parameters. Samples were analysed for various projects like proposed port at Nandgaon, Thane, Maharashtra; Punatsangchu II HE Project, Bhutan; Tarli Dam, Satara, Maharashtra; Devsari HE Project Uttarakhand; Mandechhu HE Project Bhutan; Theronda Creek, Raighad, Maharashtra; Barna dam, Madhya Pradesh; Mahi dam, Madhya Pradesh and Khadakwasla reservoir etc.

Water quality monitoring system

PART-III
DISSEMINATION OF INFORMATION

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53. Vaidya A.M. (Mrs.), Santosh K. Kori, M.D. Kudale "Influence of Mesh Resolution on Simulation of Wave Propagation in Coastal Area", HYDRO 2013 (International), PP. 58, December 2013

54. Vaidya A.M.(Mrs.), K.H. Barve, M.D. Kudale "Mathematical modeling of Short wave Propagation over a Complex Bathymetry", INCHOE-2014,Dona Paula, Goa, pp 282-286,February 2014

55. Verma M.K., M.Z. Qamar, A.P. Meshram "Design Aspects and Model Studies for Silt Flushing Tunnels in Hydro Power Projects', International Journal of Emerging Technology and Advanced Engineering (IJETAE), Vol. 3, Issue 12, December 2013

56. Verma Mukesh, M.Z. Qamar, Dr. Mrs. V.V. Bhosekar "Desilting Mechanisms for Hydro Power Projects", Magazine "Standards India", STD IND Vol : 27 No.412/12 July 2013, August 2013

57. Vijaygopal P., N. Vivekanandan, S. Kannan "Assessing Adequacy of Probability Distribution for Development of IDF Relationship for Mandla and Jabalpur", International Journal of Scientific Research and Reviews", IJSRR 2013, 2(3), 99-114, September 2013

58. Vivekanandan N. "Entropy Based Assessment on Optimization of Streamflow Network", Journal of Applied Hydrology, Vol. XXV, No.1&2, Jan & Apr. 2012,August 2012

59. Vivekanandan N., R.S. Jagtap "Evaluation and Selection of Rain Gauge Network using Entropy, Journal of Institution of Engineers, July 2013

60. Yadav Rajeev Kumar, Bhaskar Kundu, Kalpana Gahalaut, Joshi Catherine, Vineet K. Gahalaut, A. Ambikapathy, M.S. Naidu "Coseismic offsets due to the 11 April 2012 Indian Ocean earthquakes (Mw 8.6. and 8.2) derived from GPS measurements, International (SCI) journal Geophysical Research Letter, Vol.40, 3393, doi:10.1002/grl.50601, 2013, December 2013

PARTICIPAPTION IN SEMINARS/ SYMPOSIA/ CONFERENCES/ WORKSHOPS

Sl. No.	Event	Organiser, Place, Date	Name of Officer
1.	Dam India 2013	Dam India 2013, New Delhi, 22 May 2013	Gupta I.D. (Dr.), Director
2.	National Seminar on "Explosives and Blasting for Mining, Quarrying & Infrastructure Industry (EBTMQI)	Dept. of Mining Engg., NITK, Surathkal 27-28 September 2013	Tripathi G.R. (Dr.), SRO
3.	One day Symposium on "Outstanding Issues for Hydrological Research in India"	NITK, Surathkal, 21.10.2013	Kannan S., ARO Vivekanandan N., ARO
4	3rd National Conference on Role of Oceans in Earth System-OSICON-13	IITM, Pune, 26-28 November 2013	Purohit A.A., CRO
5.	HYDRO-2013	HYDRO-2013, IIT Madras, Chennai, 4-6 December 2013	Kudale M.D., JD, Bhosekar V.V.(Dr.)(Mrs.), JD Vaidya A.M. (Mrs.), CRO Prabhat Chandra, CRO Ranganath L.R., CRO Singh Raghuram, RO Jagtap S.P., ARO
6.	International Conference on "Water Energy and Climate Change - Towards a Sustainable Global Future"	IJPRVD, Kolkatta, 19-20 December 2013	Abdul Rahiman P.M., CRO
7.	Conference IASLIC-XXIX-All India Conference	Information Centre & Library, NIV, Pune, 26-29 December 2013	Rao M.M. (Dr.), LIO N.B. Minz (mrs.), LIA
8.	50th Annual Convention on "Sustainability of Earth System - The Future Challenges"	IGU & CSIR-NGRI, Hyderabad, 9-12 January 2014	Krishnaiah C. (Dr.), CRO

9.	Fifth National Conference on Harbour Ocean (INCHOE-2014)	INCHOE-2014, CSIR-National Institute of Oceonography, Dona Paula, Goa, 5-7 February 2014	Kudale M.D., JD Vaidya A.M. (Mrs.), CRO Ranganath L.R., CRO Manjunatha S.G., CRO Pardeshi A.B. (Mrs.), SRO Gopikrishna B. Shukla V.K. Chavan S.S. Patil H.C. Manivanan R. (Dr.) Barve A.S. (Mrs.) Singh A.K. (Dr.) Mahalingaiah A.V.
10.	Seminar on "Canal Automation"	CBIP, New Delhi, 6-7 February 2014	Banotu Raghuram Singh
11.	National Seminar on “Innovative Practices in Rock Mechanics (IPRM-2014)	Bengaluru, 6-7 February 2014	Ammani Ambikapathy, RA
12.	Seminar on "Hydrometry"	CWPRS, Pune, 13-14 February 2014	Bhosekar V.V. (Dr.) (Mrs.) Patil R.G. (Dr.) Neena Isaac (Mrs.) Selva Balan M
13.	National seminar on "Physics and Technology of Sensors (NSPTS - 18)	Tuljaram Chaturchand College, Baramati, 6-8 March 2014	Dorle P.K , RO Erande R.S. (Mrs.), ARO

PARTICIPATION IN TRAINING PROGRAMS

Sl. No.	Event	Organizer	Date and Place	Name of officer(s)
1.	Workshop on Trainers of Trainees – under HP -II	NWA, Pune	25 April 2013, NWA, Pune	Vivekanandan N. ARO
2.	Workshop on "Case studies of Energy Conservation in Refrigeration, Heating, Ventilation & Air conditioning (HVAC) Systems"	Central Power Research Institute (CPRI), Bangalore	6-7 June 2013 CPRI, Bangalore	Swain T.K., RO
3.	Training programme for Non Engineering Officers in "Management Development"	NWA, Pune	24-28 June 2013 NWA, Pune	Rayawagol P.B., Suptd. (Admin)
4.	Training programme on "Ground Vibration Monitoring with Digital Seismograph & Vibration Analysis Software"	Deeptec Infrastructures, Hadapsar, Pune	25 June 2013 Pune	Tripathi G.R. (Dr.), SRO
5.	Training programme on "Dam Safety Aspects & Instrumentation"	NWA, Pune	19-23 Aug 2013 NWA, Pune	Minoti Das (Mrs.), ARO
6.	Training programme on "Dam Safety Aspects & Instrumentation"	NWA, Pune	19-23 Aug 2013 NWA, Pune	Jyotsna G. Ambekar (Ms.),RA
7.	Training Programme on "Design of Barrages & Canals"	NWA, Pune	12-16 Aug 2013 NWA, Pune	Suresh Kumar B., RO
8.	Training Programme on Results-Framework Management System (RFMS)	MoWR, New Delhi	22 Aug 2013 MoWR, New Delhi	Ranganath L.R., CRO
9.	ANSYS Design Modeler & ANSYS Mechanical Introduction Training	ANSYS, Hinjewadi, Pune	2-5 Sep 2013, Hinjewadi Pune	Sarvesh D. Pingale, RA

10.	Training Programme on "Advanced Watershed Modelling in Water Resources (Under HP-II)"	NWA, Pune, 23-	27.09.2013 NWA, Pune	Vivekanandan N. ARO Jhuma Rano (Miss), RA
11.	Training Course on "Storm Water Management for Power Plants"	CWPRS, Pune	24-26 Sep 2013 CWPRS, Pune	Narasayya K., ARO Kadam Ajit, RA Golandaj A.G., RA Shinde A.S. (Mrs.), RA Abha Garg (Ms.), RA
12.	1-day workshop on Hydrology Project II	HP II (PCS), MoWR	1.10.2013, Goa	Jagtap R.S., JD
13.	Workshop on "Real time streamflow forecast and Reservoir operation system for Krishna and Bhima basins of Maharashtra"	YASHADA, Baner Road, Pune	3.10.2013, YASHADA, Baner Road, Pune	Jagtap R.S., JD Khatarkar P.R. CRO Ramesh C. (Dr.), SRO Pratap Singh Solanki, ARO
14.	Training course on "Water Quality & Environment for Hydro Structures"	CSMRS, New Delhi	06-08 Nov 2013, CSMRS, New Delhi	Prabhakar V.M (Dr.), ARO
15.	Training Programme on "Fundamentals of Hydro Power Projects"	NWA, Pune	18-22 Nov 2013, NWA, Pune	Naidu M.S.R., RO
16.	Training programme on "Fundamentals of Hydro Power Projects"	NWA, Pune	18-22 Nov 2013, NWA, Pune	Bist Mahender Singh, RO
17.	International Training Course on "Long lead-time Ensemble River and flood forecasting"	NIH, Roorkee	18-23 Nov 2013, NIH, Roorkee	Vivekanandan N., ARO
18.	International Training Course on "Long lead-time Ensemble River and flood forecasting"	NIH, Roorkee	18-23 Nov 2013, NIH, Roorkee	Kadam Ajit, RA
19.	Training course on "Contribution of CWPRS for Hydropower Development - Hydraulic Aspects"	CWPRS, Pune	27-28 Nov 2013, CWPRS, Pune	Vishal Telgote, RA

20.	Training course on "Contribution of CWPRS for Hydropower Development - Hydraulic Aspects"	CWPRS, Pune	27-28 Nov 2013	Ms Madhavi Gajre, RA
21.	Training Programme on "Hands on Advanced Instruments of Water Quality Testing"	NIH, Roorkee	2-6 Dec 2013, NIH, Roorkee	Hansda Savitri (Miss), RO
22.	TOT programme on "Storm Analysis and Preparation of PMP Atlases and HDA2 : Estimation of Design Flood	NWA, Pune	16-21 Dec 2013, NWA, Pune	Vivekanandan N., ARO K. Narasayya, ARO Jhuma Rano (Miss), ARO
23.	Training Programme on "Digital Surface Modelling & Watershed Modelling"	NWA, Pune	2-13 Dec 2013, NWA, Pune	Selva Balan M, CRO Suneeta Jatwa, RO Solanki Pratap Singh, ARO Kandagale H.R., ARO
24.	Training Workshop on "Groundwater Resources Management"	NIH, Belgaum	11-13 Dec 2013, NIH, Belgaum	Krishnaiah C. (Dr.), CRO
25.	ToT programme on "HDA3: Sediment Rate Estimation and SWAT applications	NWA, Pune	13-17 January 2014, NWA, Pune	Srishailam C, RO Ali Syed Naveed, RO Garg abha A (Miss), RA
26.	Training course on "Records Management for Right to Information"	ISTM, New Delhi	15-17 January 2014, ISTM, New Delhi	Rajendra Aswale, CAO
27.	Training programme on "Cost Engineering"	NWA, Pune	20-24 January 2014, NWA, Pune	Walke Kapil G, RA
28.	Training program on "Pumped Storage Hydro Electric Projects"	NWA, Pune	27-31 January 2014, NWA, Pune	Sahoo G. C, RO Ghule S.J, ARO Farande K.U, ARO
29.	Workshop on "Application of Remote Sensing in Water Quality Assessment"	Goa University, Goa	26-28 February 2014, Goa University, Goa	Vaidya S.P. (Mrs.) (Dr.), CRO Gupta K.K., SRO

30.	Six week Induction Training programme for JTS officers of ISS promoted from SSS	NASA, Grater Noida	10 Feb-21 Mar 2014, NASA, Grater Noida,	Powale I.I, RO
31.	Training programme on "Flood Inundation Mapping including use of RS-GIS"	NWA, Pune	24-28 February 2014, NWA, Pune	Kunjeer P.S., RO Patil Parag Devidas, RO Archana S Shinde (Mrs), RA
32.	Training programme on "Science Administration and Research Management"	ASCI, Hyderabad	10-21 February 2014, ASCI, Hyderabad	Bhajantri M.R., CRO Jagadeesh H.B., CRO
33.	Workshop on "Hydrological Analysis using Statistical and Stochastic Technique : Special reference to Flood Estimation"	NIH, Roorkee	24-28 February 2014, NIH, Roorkee	Vivekanandan N., ARO

COURSES ORGANIZED

1. Training Programme on "Dam Safety Rehabilitation" during 15-17 April 2013
2. Training Course on "Coastal Erosion and Protection" during 21-23 August 2013
3. Training Programme on "Dam Safety and Rehabilitation" for Ghana Engineers was organized at CWRPS in association with WAPCOS, New Delhi during 17-19 September 2013
4. Training programme on "Storm Water Management for Power Plants" was held at CWPRS during 24-26 September 2013
5. Short Course on " Modeling techniques for sediment transport in Coastal Engineering" was held at CWPRS during 09-10 October 2013
6. CWPRS, Pune conducted Long Hydrographic Course during 18-22 November 2013 which was attended by a team of 14 Naval Officers from National Institute of Hydrography (NIH), Goa.
7. Training course on "Contribution of CWPRS for Hydropower Development-Hydraulic Aspects was conducted at CWPRS during 27-28 November 2013
8. A short course on "River Training and Management" was organized at CWPRS during 29-31 January 2014.
9. Training Course on "Structural Safety Concerns of Hydro Power Projects-Role of CWPRS" was held during 21-23 January 2014 at CWPRS, Pune
10. Training course of Geophysical Investigations for Engineering Projects was conducted at CWPRS during 5-7 February 2014 at CWPRS, Pune
11. Seminar on "Hydrometry" was conducted jointly by BIS & CWPRS, Pune during 13-14 February 2014 at CWPRS, Pune

INVITED LECTURES DELIVERED

Sl. No.	Title	Event, Place, Date	Name of Officer
1.	Liquefaction potential of foundation of earth dam	Forum Lecture, R&D, Dighi, 05 April 2013	Murlidhar B., SRO
2.	Coastal Process	Training programme for newly promoted Asstt. Directors-1/Asstt. Exe. Engineer, CWC, NWA, Pune, 7 May 2013	Agrawal J.D. (Dr.), CRO
3.	Coastal Sedimentation	Training programme for newly promoted Asstt. Directors-1/Asstt. Exe. Engineer, CWC, NWA, Pune, 7 May 2013	T Nagendra, JD
4.	Coastal Protection Schemes	Training programme for newly promoted Asstt. Directors-1/Asstt. Exe. Engineer, CWC, NWA, Pune, 8 May 2013	Kudale M.D., JD
5.	Topics in number theory	International Mathematical Olympiad Training Camp (IMOTC), HBCSE, Mumbai, 13-18 May 2013	Kiran Barve, ARO
6.	Importance of Model Studies	Induction Training Programme for newly promoted Asst. Directors-I CWC, NWA, Pune, 20 May 2013	Bhajantri M.R. (Dr.), CRO
7.	Hydraulic Desing of Dams and Appurtenant Structures	Induction Training Programme for newly promoted Asst. Directors-I CWC, NWA, Pune, 20 May 2013	Bhosekar V.V. (Dr.) (Mrs.), JD
8.	Seismological Investigation of River Valley Projects	Induction Training Programme for newly promoted Asst. Directors/ Asstt. Executive Engineer CWC, NWA, Pune, 31 May 2013	Shende V.J. (Mrs.), CRO
9.	Use of Global positioning System	Induction Training Programme for promoted Asstt. Directors/Asstt. Executive Engineer, CWC, NWA, Pune, 3 June 2013	Selva Balan M, SRO

10.	Case Study on Reservoir Sedimentation	Induction Training Programme for promoted Asstt. Directors/Asstt. Executive Engineer, CWC, NWA Pune, 6 June 2013	Roman U.C., CRO
11.	Office Procedures - An Overview Pay, Leave Rules, PF, TA	Induction Training Programme for promoted Asstt. Directors/Asstt. Executive Engineer, CWC, NWA, Pune, 13 June 2013	Godhwani L.D., FO
12.	Prediction of blast vibration	Training programme on "Ground Vibration Monitoring with Digital Seismograph & Vibration Analysis Software", NWA, Pune, 25 June 2013	Tripathi G.R. (Dr.), SRO
13.	Geo-Technical investigation & Foundation Treatment with special reference to concrete and masonry dam along with a case study	Training Programme under Core Area: "Civil/Structural Design", NWA, Pune, 30 July 2013	Dhawan K.R. (Dr.), CRO
14.	Importance of model studies in design of spillways & energy dissipaters	Training Programme under Core Area : Civil/ Structural Design", NWA, Pune, 31 July 2013	Bhosekar V.V. (Dr.) (Mrs.), JD
15.	Selection of seismic design parameters and fundamentals of Dynamic Analysis for design of dams (Concrete & Masonry)	Training Programme under Core Area : Civil/ Structural Design", NWA, Pune, 31 July 2013	Pattanur L.R. (Dr.) (Ms), SRO
16.	'Application of HEC-RAS sediment transport and deposition in Reservoirs'	Training Programme on Reservoir Sedimentation", ESCI, Hyderabad, 02.08.2013	Neena Isaac (Mrs.), CRO
17.	Application of FEM in Design of concrete & Masonry Dam : Static and Dynamic Analysis with case study	Training Programme under Core Area : Civil/ Structural Design", NWA, Pune, 01.08.2013	Rizwan Ali, SRO

18.	Seepage Control Measures in earth and Rockfill Dams	Training Programme under Core Area: Civil/ Structural Design", NWA, Pune, 06.08.2013	Desai V.T., SRO
19.	Dynamic properties of soil and triaxial tests	Training Programme under Core Area: Civil/ Structural Design", NWA, Pune, 06.08.2013	Murlidhar B., SRO
20.	Role of CWPRS in Water Resources Development and management	26th Induction Training Program (ITP) for the new appointees of CWC (Group-A) Services, NWA, Pune, 08.08.2013	Bhosekar V.V.(Dr.) (Mrs.), JD
21.	Statistical Methods used in Hydrology	Training Programme on 26 ITP for newly appointed officers of CWC (Group A), NWA, Pune, 28.08.2013	Jagtap R.S., JD
22.	Design of Canal Automation System	Training Programme on "Design of Barrages and Canals", NWA, Pune, 12-16.08.2013	Mukesh Arora, SRO
23.	Safety Review and Rehabilitation of Concrete Dams	Training Programme on "Dam Safety Aspects & Instrumentation", NWA, Pune, 22.08.2013	Rizwan Ali, SRO
24.	Safety Review and Rehabilitation of Concrete Dams	ITP for newly jointed CWES officers, NWA, Pune, 22.08.2013	Rizwan Ali, SRO
25.	Data Acquisition & wireless data & Transmission System for Dam structure	Training Programme on "Dam Safety Aspects & Instrumentation", NWA, Pune, 20.08.2013,	Selva Balan M, SRO
26.	Data Acquisition & Wireless Data & Transmission System for Dam structure	ITP for newly joined CWES officers, NWA, Pune, 20.08.2013	Selva Balan M, SRO
27.	Seismic parameter assessment and Analysis for Safety Evaluation of Dams	Training Programme on "Dam Safety Aspects & Instrumentation", NWA, Pune, 20.08.2013	Pattanur L.R. (Dr.) (Ms), SRO
28.	Seismic parameter assessment and Analysis for Safety Evaluation of Dams	ITP for newly joined CWES officers, NWA, Pune, 20.08.2013	Pattanur L.R. (Dr.) (Ms), SRO

29.	Safety review and Rehabilitation of Embankment and Rockfill Dam	Training Programme on "Dam Safety Aspects & Instrumentation", NWA, Pune, 19.08.2013`	Murlidhar B., SRO
30.	Safety Review and Rehabilitation of Embankment and Rockfill Dam	ITP for newly joined CWES Officers, NWA, Pune, 20.08.2013	Murlidhar B., SRO
31.	Hydraulic Design of Water Conductor System :Desilting Chambers - An Overview and Model Studies	Training Programme under Core Area: "Civil/Structural Design", NWA, Pune, 28.08.2013	Mohd. Zia Ul Qamar, RO
32.	Sediment Management in Hydropower Projects	Training Programme under Core Area: "Civil/Structural Design", NWA, Pune, 28.08.2013	Pawar M.K, CRO
33.	Stress Analysis for Underground opening by FEM	Training Programme under Core Area: "Civil/Structural Design", NWA, Pune, 28.08.2013	Dhawan K.R. (Dr.), CRO
34.	Hydro Dynamic forces on vertical lift gates, stoplog gates and high head gates of hydropower projects	Training Programme under Core Area: "Civil/Structural Design", NWA, Pune,	Patil R.G. (Dr.), CRO
35.	Statistical Analysis in Modeling	Training Programme on 26 ITP for newly appointed officers of CWC (Group A), NWA, Pune, 9.09.2013	Jagtap R.S., JD
36.	Vigilance Disciplinary Rules	26th Induction Training programme for newly appointees of CWE (Group-A) Services, NWA, Pune, 26.09.2013	Rajendra Aswale, CAO
37.	Sangha ki Rajabhasha Neeti Evam Karyanvayan	26th Induction Training programme for newly appointees of CWE (Group-A) Services, NWA, Pune, 27.09.2013	Gupta K.K., SRO
38.	Right to Information Act 2005	26th Induction Training programme for newly appointees of CWE (Group-A) Services, NWA, Pune, 27.09.2013	Rajendra Aswale, CAO

39.	River Training Works	26th Induction Training Program (ITP) for the new appointees training programme, 22.10.2013, NWA, Pune	Kunjeer P.S., RO
40.	Customization in ArcGIS with Visual BASIC	26th Induction Training Program (ITP) for the new appointees training programme, 22.10.2013, NWA, Pune	Pratap Singh Solanki, ARO
41.	Use of River morphology and sediment analysis software"	26th Induction Training Program (ITP) for the new appointees training programme, 22.10.2013, NWA, Pune	Tarudkar P.H., ARO
42.	Case Study on reservoir sedimentation Part-I Concepts & Methodology	26th Induction Training Program (ITP) for the new appointees training programme, 25.10.2013, NWA, Pune	Roman U.C., CRO
43.	Case study on reservoir sedimentation Part II - Panshet reservoir	26th Induction Training Program (ITP) for the new appointees training programme, 25.10.2013, NWA, Pune	Roman U.C., CRO
44.	Global Positioning System (GPS) and its application to Water Resources System	Training Programme on "Application of Information Technology in Irrigation Water Management System", NWA, Pune, 11.11.2013	Selva Balan M, CRO
45.	Supervisory Control and Data Acquisition (SCADA) and its working for canal automation	Training Programme on "Application of Information Technology in Irrigation Water Management System", NWA, Pune, 16.11.2013	Selva Balan M, CRO
46.	Selection of turbines for Hydro Electric Projects	Training Programme on "Fundamentals of Hydropower Projects", NWA, Pune, 18-22.11.2013	Goel P.K., JD
47.	Preliminary designs of Electro Mechanical Equipments	Training Programme on "Fundamentals of Hydropower Projects", NWA, Pune, 18-22.11.2013	Abdul Rahiman P.M., CRO
48.	Application of GPS in GIS environment	Training Programme on "Digital Surface Modelling & Watershed Modelling", NWA, Pune, 2-13 December 2013	Selva Balan M, CRO

49.	Broad topics of River Behaviour, training and management	Short course on "Sediment Transport and River Engineering", IIT Bombay, Powai, 9-13 December 2013	Patil R.G. (Dr.), CRO
50.	Broad topics of River Behaviour, training and management	Short course on "Sediment Transport and River Engineering", IIT Bombay, Powai, 9-13 December 2013	Arun Kumar, RO
51.	Fundamentals of geophysical methods for subsurface exploration with special emphasis on the GPR Techniques	Workshop on "Quaternary Geology and Climate Change", Pune University, 6-19 January 2014	Chaudhari M.S., SRO
52.	Renovation, modernization and up-rating of pumped storage Hydro Electrical Projects	Training programme on "Pumped storage Hydroelectric Projects", NWA, Pune, 27-31 January 2014	Goel P.K., JD
53.	Statistical measures - Manual and systematic errors, Statistical estimate concept of confidence band and confidence limit, Dispersion of observed data and its causative factors, random errors Hands on	26th ITP (Part-II) for newly appointed officers of CWC (Group A) Services", NWA, Pune, 12 February 2014	Jagtap R.S., JD
54.	Statistical measures - Central tendency measures, Measure of dispersion through standard error of estimate , Standard error of mean relationship, Generation of no break discharge series, hands on	26th ITP (Part-II) for newly appointed officers of CWC (Group A) Services", NWA, Pune, 12 February 2014	Jagtap R.S., JD
55.	Statistical measures - probability concepts, Distribution types, Central limit theorem, Hands on	26th ITP (Part-II) for newly appointed officers of CWC (Group A) Services", NWA, Pune, 12 February 2014	Jagtap R.S., JD

56.	Development of rating curve, processing and validation of stream flow data, hands on	26th ITP (Part-II) for newly appointed officers of CWC (Group A) Services", NWA, Pune, 13 February 2014	Vivekanandan N., ARO
57.	Methods for developing rating curve, fitting of Rating curve, stability of rating curve, uncertainty estimation, hands on	26th ITP (Part-II) for newly appointed officers of CWC (Group A) Services", NWA, Pune, 13 February 2014	Vivekanandan N., ARO
58.	Rating curve validation, different types of station control, extrapolation of rating curves, hands on	26th ITP (Part-II) for newly appointed officers of CWC (Group A) Services", NWA, Pune, 13 February 2014	Vivekanandan N., ARO
59.	Shifts in discharge ratings, ratsing curve with backwater correction - hands on	26th ITP (Part-II) for newly appointed officers of CWC (Group A) Services", NWA, Pune, 13 February 2014	Vivekanandan N., ARO
60.	Coastal erosion and protection	26th ITP (Part-II) for newly appointed officers of CWC (Group A) Services", NWA, Pune, 21 February 2014	Kudale M.D., JD
61.	Design of coastal protection structures	26th ITP (Part-II) for newly appointed officers of CWC (Group A) Services" NWA, Pune, 21 February 2014	Mahalingaiah A.V., CRO
62.	Innovative methods of coastal protection	26th ITP (Part-II) for newly appointed officers of CWC (Group A) Services" NWA, Pune, 21 February 2014	Tayade Bhushan R., RO
63.	Field data requirement for coastal protection works	26th ITP (Part-II) for newly appointed officers of CWC (Group A) Services" NWA, Pune, 21 February 2014	Vaidya M.M., RO
64.	Survey using DGPS	26th ITP (Part-II) for newly appointed officers of CWC (Group A) Services", NWA, Pune, 20 February 2014	Selva Balan M, CRO
65.	Flood and Flood Statistic	Training programme on "Flood Warning Section" NWA, Pune, 26 February 2014	Ramesh C. (Dr.), SRO

66.	Hands on session	Training programme on "Flood Warning Section" NWA, Pune, 26 February 2014	Ramesh C. (Dr.), SRO
67.	Dynamic analysis of earth dams and liquefaction potential of foundation	Workshop on "Subsurface Investigation & Foundation for High rise Structures", Padmashir Dr.Vithalrao Vikhe Patil College of Engineering, Ahmednagar, 12 February 2014	Murlidhar B., SRO
68.	Statistical techniques in water resources	National Seminar on "Application of Mathematics & Statistics in Life Sciences", Mohite College, Pune, 07.03.2014	Jagtap R.S., JD

CONTRIBUTIONS TO BIS AND ISO STANDARDS

ISO Standards Drafted

1. ISO 18481 Hydrometry – Liquid flow measurement using end-depth method in channels with a free overfall

ISO Standards Reviewed

1. ISO 748:2007 `Hydrometry - Measurement of liquid flow in open channels using current meters or floats
2. ISO 1438:2008 "Hydrometry-Open channel flow measurement using thin plate weirs
3. ISO/ TS 3716:2006 Hydrometry – Functional requirements and characteristics of suspended sediment samplers
4. ISO 4365:2005 Liquid flow in open channels -- Sediment in streams and canals -- Determination of concentration, particle size distribution and relative density
5. ISO 4369:1979 Measurement of liquid flow in open channels -- Moving-boat method
6. ISO/ DIS 4375 " Hydrometric determinations -Cableway systems for stream gauging"
7. ISO 6416:2004 Measurement of discharge by the ultrasonic transit time (time of flight) method
8. ISO/TR 9210 – Hydrometry - Measurement in meandering rivers and in streams with unstable boundaries
9. ISO/PDTR 9212 'Hydrometry – Method of measurement of bed load discharge
10. ISO 9213:2004 "Measurement of total discharge in open channels -- Electromagnetic method using a full-channel-width coil"
11. ISO 9826:1992 'Measurement of liquid flow in open channels- Parshall and SANIIRI Flumes
12. ISO/ TR 11651 Estimation of sediment deposition in reservoir using one dimensional simulation models
13. ISO/FDIS 11657 "Hydrometry – Suspended sediment in streams and canals-Determination of concentration by surrogate techniques
14. ISO 13550:2002 'Hydrometric determinations- Flow measurements in open channels using structures- Use of vertical underflow gates and radial gates
15. ISO/TS 15768:2000 Measurement of liquid velocity in open channels -- Design, selection and use of electromagnetic current meters

16. ISO/TS 24155:2007Hydrometric data transmission systems - Specification of system requirements

BIS Standards Printed

1. IS 1192:2013 Measurement of liquid flow in open channels using current - meters or floats (second revision)
2. IS 3910:2013 Hydrometry - Rotating-Element Current-Meters(second revision)
3. IS 6339:2013 Hydrometry - Sediment in streams and canals -Determination of concentration, particle size distribution and relative density (first revision)
4. IS 9108:2013 Hydrometry - Open channel flow measurement using thin-plate weirs (first revision)
5. IS 12752:2013 Hydrometric Determinations - Flow Measurements in Open Channels using Structures - Guidelines for Selection of Structure (first revision)

Draft Standards under Finalization

1. Doc. WRD 01(613) Hydrometry - Velocity-area methods using current-meters - Collection and processing of data for determination of uncertainties in flow measurement (First revision of IS 14573 and Adoption of ISO 1088:2007)
2. Doc. WRD 01(614) Hydrometry- Measurement of liquid flow in open channels-Part 2: Determination of the stage-discharge relationship (First revision of IS 15119(Part 2) and Adoption of ISO 1100-2:2010)
3. Doc. WRD 01(615) Hydrometry - Measurement of liquid flow in open channels under tidal conditions (First revision of IS 15122:2002 and Adoption of ISO 2425:2010)
4. Doc. WRD 01(616) Hydrometry - Open channel flow measurement using triangular profile weirs (First revision of IS 14673 and Adoption of ISO 4360:2008)
5. Doc. WRD 01(617) Hydrometry - Water Level Measuring Devices (First revision of IS 15118 and Adoption of ISO 4373:2008)
6. Doc. WRD 01(618) Hydrometry- Guidelines for the application of acoustic velocity meters using the Doppler and echo correlation methods (Adoption of ISO 15769:2010)

Standards Finalized

1. Hydrometric Determinations-Flow Measurement In Open Channels Using Structures – Flat-V Weirs (first revision of IS 13038 and identical to ISO 4377:2012)
2. Hydrometry–Hydrometric data transmission systems – Specification of system requirements (identical to ISO/TS 24155:2007)
3. Hydrometry-Acoustic Doppler profiler–Method and application for measurement of flow in open channels (identical to ISO/TR 24578:2012
4. Hydrometry- Vocabulary and Symbols (third revision of IS 1191 and technically equivalent to ISO 772:2011)

PARTICIPATION IN MEETINGS OF TECHNICAL COMMITTEES

Sl. No.	Name of Committee	Date and Venue	Participant(s)
1.	13th meeting of Coastal Protection and Development Advisory Committee (CPDAC) in context of Anti Sea Erosion Measures in Lakshadweep	16-20 April 2013 Lakshadweep	Agrawal J.D.(Dr.), CRO
2.	9th Empowered Committee meeting regarding the status and progress of Mithi river development programme	20 May 2013 Mantralaya, Mumbai	T Nagendra, JD Patil U.B, RO
3.	Meeting of Technical Sub-Committee of Coastal and Environment for the development of the proposed Vizhinjam International Seaport, Kerala	03.06.2013 Thiruvananthapuram	M.D. Kudale, JD
4.	Attend meeting of National Committee on Seismic Design and Parameters	28.06.2013 CWC, New Delhi	Dr. I.D. Gupta, Director
5.	Parliamentary Standing Committee Meeting	1-2 July 2013 Mumbai	Dr. I.D. Gupta, Director S. Govindan, AD Pawar M.K, CRO Roman U.C, SRO Aswale R.R, CAO
6.	Attend meeting of National Committee on Seismic Design and Parameters	08.07.2013 CWC, New Delhi	Dr. I.D. Gupta, Director
7.	BIS committee meeting	18.07.2013 New Delhi	Patil R.G. (Dr.), CRO
8.	WRD1:1 Subcommittee for ISO work	18.07.2013 BIS, New Delhi	Bhosekar V.V. (Dr.) (Mrs.), JD Neena Isaac (Mrs.), CRO
9.	Emergent Technical Advisory Committee (TAC) meeting of Farakka Barrage Project	27-28 July 2013 Farakka	Arun Kumar, RO
10.	WRD1 committee meeting	24-25 September 2013, New Delhi	Gupta I.D.(Dr), DIRECTOR
11.	1st meeting of the committee constituted to chalk out the modalities of participation of MoWR in IITF 2013	03 October 2013 MoWR, New Delhi	S. Govindan, DIRECTOR

12.	2nd meeting of the committee constituted to chalk out the modalities of participation of MoWR in IITF 2013	11 October 2013 at MoWR, New Delhi	S. Govindan, DIRECTOR
13	Kosi High level committee meeting	15-18 Nov 2013 Birpur, Bihar	Shri. M.N.Singh, JD Shri. Sanjay A Burele, RO
14.	First meeting of Committee on Dredging issues related to OCT project	2 December 2013, Mumbai	Purohit A.A.CRO Murlidhar B.SRO Vaidya M.M.RO
15.	109th Technical Advisory Committee meeting of Farakka Barrage Project on	19-21 December 2013 Farakka, West Bengal	Patil R.G. (Dr.)
16.	Second meeting of Committee on Dredging issues related to OCT project	23 December 2013, Mumbai	Purohit A.A.CRO Vaidya M.M.RO
17.	14th Meeting of "Coastal Protection and Development Advisory Committee (CPDAC)"	27-28 Feb 2014, Goa	Kudale M.D., J.D.
18.	4th Meeting of committee on dredging issues related to OCT project, Mumbai	2 February 2014, Mumbai	Purohit A.A., CRO
19.	Sub Committee meeting for Karanja Fishing Harbour, Dist. Raigad to finalize the revised layout plan & rate analysis for removing sub marine rock etc.	14.03.2014 Mumbai	Shri M.D. Kudale, JD
20.	First meeting of Indian National Committee for International Hydrological Programme (INCIHP) of UNESCO	20.03.2014 Seva Bhavan, New Delhi	Shri R.S. Jagtap, JD

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