A DAY WORKSHOP
ON
RIVER TRAINING WORKS
IN
NATIONAL WATERWAYS
9th MAY, 2008

PROCEEDINGS
AND
RECOMMENDATIONS

VENUE

NATIONAL INLAND NAVIGATION INSTITUTE

(Inland Waterways Authority of India)

(M/o Shipping, Road Transport and Highways, Govt. of India)

Gaighat, Patna – 800007, Tel - 0612-2310555

Website: http://www.iwai.nic.in/nini.htm

Inauguration of work shop by Chief Guest Shri S. C Srivastava, Member (C & F), IWAI

Welcome address by Capt(IN) G. S. Inda, Hydrographic Chief

Message from Chairman, IWAI being delivered by Shri S. S Pandian, Chief Engineer, IWAI

Address by dr. D. S. Bhargava, Chief resource person

Workshop

राष्ट्रीय जलमार्गों (रा०ज०) में नदी ट्रेनिंग संबंधी

कार्यों पर राष्ट्रीय अन्तर्देशीय नौवहन संस्थान (निनी)

में आयोजित कार्यशाला की कार्यवाही एवं सिफारिशें

PROCEEDINGS AND RECOMMENDATIONS OF

WORKSHOP ON "RIVER TRAINING WORKS"

IN NATIONAL WATERWAYS (NWs) HELD AT

NATIONAL INLAND NAVIGATION INSTITUTE (NINI)

गायघाट, पटना में 09 मई, 2008 को

GAIGHAT, PATNA ON 09 MAY, 2008

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MESSAGE FROM CHAIRMAN, IWAI

I am very glad to know that a Workshop on River Training is being organized on 9th May, 2008 at NINI, Patna. As everyone knows, the biggest challenge before IWAI is to provide a stable and reliable fairway for the two major rivers viz the Ganga (NW-1) and the Brahmaputra (NW-2) so that it could provide an alternative mode of transportation. After acquiring an experience of river conservancy measures like dredging and bandalling for the past 20 years, IWAI is now working upon introducing and implementing innovative channel stabilization techniques in the form of river training works, both in Ganga and Brahmaputra. It is hoped that this Workshop will lay the foundation for IWAI's effort to that direction. I am thankful to the eminent resource persons in the fields of river training, bank protection and soil erosion who have accepted the invitation of IWAI to participate in this Workshop and share their expertise with IWAI. I hope that a fruitful and meaningful discussion and deliberations will be held on all the papers and at the end of the Workshop realistic conclusion will be drawn so that IWAI & other agencies can implement the same with the assistance and guidance of the experts present here.

I wish all the very best to the resource persons, invitees, participants and organizers of this Workshop.

(S.P.GAUR, IAS)
Chairman, IWAI

INAUGURAL ADDRESS BY MEMBER (C & F), IWAI

Today we are here to discuss the importance of River Training as a permanent solution to the silting and meandering nature of the national waterways. We need to find specific methodology for different section of the river as may be suitable to them.

As you all know, Inland Waterways Authority of India (IWAI) is a statutory body set up by an Act of Parliament in 1985 under the Ministry of Shipping, Road Transport and Highway, Government of India, is vested with responsibility for development and regulation of National Waterways. Till date three National Waterways have been declared by Govt. of India.

Even after 23 years of IWAI's establishment, we are trying our level best to train and maintain our rivers as per requirement. In this regard, it is important to discuss various scientific methods being adopted by different organizations in this world. We also know that the river training is only answer to ensure desired depth of water for safe navigation on National Waterways, in India. To develop a stable and reliable fairway on a permanent basis, scientific river training works are required. For this, the flow of two major rivers needed to be properly understood to overcome the problem. We require at least 2.0 meter water depth and 45 meter width for adequate 2 lane fairway navigation. The investment needed for 'River training' is large and therefore the programme needs to be drawn by experts with care.

IWAI has its own cargo vessels and fully equipped terminals for mechanical handling. Private vessels should also use the river route for transportation of bulk goods on commercial basis. Though the river Ganga is not fully developed, vessels are still operating between Haldia and Patna regularly on fixed schedule sailing basis. In fact, the cargo movement in Ganga has increased in the last five years. Around 3.50 BT Kms cargo was transported in 2007–08 on all India basis. But it is not enough; we need to enhance our capacity in the coming years.

There is a growing need to develop a stable fairway, which required proper training of the river. We are facing problems in navigation because of inadequacy of knowledge. It is not a problem with us only, in abroad, they organize 'River training' workshop regularly to find out permanent solutions to the problem. This workshop will give valuable tips and demonstrate various models, which could improve efficiency in safe navigation through difficult rivers, which are full of multiple channels and shoals due to its meandering nature.

I sincerely hope that at the end of the workshop we will come out with appropriate recommendation to improve river training measures to ensure safe navigation to IWT operators.

(S.C. SRIVASTAVA)
Member (C&F), IWAI

WELCOME ADDRESS BY HYDROGRAPHIC CHIEF

On behalf of IWAI, as Hydrographic Chief and Officer-in-charge, NINI, Patna, I extend a hearty and warm welcome to you all in Patna, the capital city of Bihar. I hope your stay at Patna has been comfortable. We are honoured to welcome Shri S.C. Srivastava, Member (Cargo & Finance), IWAI & Chairman, PAC, NINI, who inspite of his busy schedule have been kind enough to accept our invitation and be the Chief Guest and be present for the duration of the workshop and guide us to discuss and deliberate on the river training measures required to maintain National waterways in the rivers Ganga and Brahmaputra. I would like to welcome Chief Resource Person Prof (Dr.) D.S. Bhargava, Ex. REC (now IIT) Roorkee and Fellow Emeritus, Institution of Surveyors, who has spared his valuable time to be the Chief Resource Person and conduct this workshop. I would like to extend our welcome to distinguished Resource Persons Shri S.K. Agarwal, Ex. Member, CWC and Consultant, NDMA, Shri Z.S. Tarapore. Ex. Director, CWP&RS and Advisor WAPCOS, Prof. U.C. Kothiyari, IIT Roorkee, Dr. Subhashisa Dutta, IIT Guwahati, Dr. Sannasiraj, IIT Chennai, Shri Pankaj Kumar, IIT Roorkee, Cdr. P.K. Srivastava, CI, NHS, Goa, Shri Bhagat Singh, Director (FM II), CWC and Shri G.P.Singh, Secretary, Brahmaputra Board. I would like to accord special welcome to my friend from industries dealing on various river training measures, Shri M.Venkataraman, Garware-wall Ropes Ltd. and Shri Prasanth J. Navalakha, Meccaferri Ltd. and their team.

Last but not the least, the participants from our IWAI, H.O. Noida, and field offices viz. Shri S.S.Pandian, CE, Dirs.(Kochi, Kolkata, Guwahati, Patna), Principal, NINI, DDs, SHS, Sr.A.O, ADs, AHSs, staff of IWAI office Patna, Faculty and trainees of NINI. Lastly, I would like to extend our special welcome to our friends from media and news channel.

Audience will agree with me that there is no better place to conduct a workshop on river training works other than at National Inland Navigation Institute located on the Gaighat of River Ganga.

River Brahmaputra is the only masculine river God. The legend goes that he came searching for the hands of the Ganges in marriage. The Ganges decided to test his love by turning herself into an old woman. When Brahmaputra failed to recognize her, she banished him to a distance. Restless, the Bahmaputra kept trying and managed to finally join the Ganges.

The rivers are the wealth and lifelines of the region and of its peoples; they are the Gods that give many times and in many ways, and yet to stay on the good side of the Gods we need to understand them. Knowledge is key to understanding these rivers.

In our contest, to maintain and develop National Waterways for safe and sustainable transportation of cargo we need to know the behaviour of the Ganga and Brahmaputra river system and make best of their traits to tame them for better and safe navigation.

It will be appropriate here to refer to poem of T S Eliot in ‘The Dry Salvages’, to understand the rivers:

“I do not know much about the gods; but I think that the river
Is a strong brown god-sullen, untamed and intractable
Patient to some degree, at first recognized as a frontier
Useful, untrustworthy, as a conveyor of commerce;
Then only a problem confronting the builder of bridges.
The problem once solved, the brown god is almost forgotten
By the dwellers in cities-ever, however implacable,
Keeping his seasons and rages, destroyer, reminder
Of what men choose to forget…….”

With these thought once again I on behalf of IWAI and organizing committee of this workshop extend hearty welcomes to one and all.

(Capt. (IN) G.S.INDA)
Hydrographic Chief, IWAI

KEYNOTE ADDRESS BY DR. D.S.BHARGAVA, EX-PROF., IIT ROORKEE

Good morning Ladies & Gentlemen. I am happy to be the Chief Resource Person of this wonderful Workshop holding at NINI, Patna by Inland Waterways Authority of India (IWAI). Here, I would like to focus on the River training issues faced by IWAI in the recent past and suggest some measures for River conservancy work in National Waterways.

The management of rivers requires (i) River training (disciplining of river routes) and protection of its banks for navigation, an economical mode of inland waterway transport, (ii) Flood control and protection of rail, road, infrastructure, etc. along the rivers and infiltrations on either side, (iii) Recreation including the development and protection of bathing *ghats* along the towns/cities situated along the rivers, (iv) Water Supply for drinking and industrial uses as well as protection of water quality along the river banks for religious rites/drinking etc. by the pilgrims/tourists, and (v) Foolproof control of river pollution along the towns/cities situated along the river through the creation of a barrier between the river and the population of towns situated along the rivers so that not even a drop of any wastewater may find any chance to enter the river and polluting it. All these requirements are automatically taken care of permanently if the river protection for navigation is done through the construction of *bandhas* (dam like longitudinal structures) or gravity retaining structures (with steps to serve as *ghats*) in the city stretches of the rivers. It will thus be a FIVE IN ONE STRATEGY. In addition to these, the various rivers are beneficially used also for (i) Irrigation and drainage, (ii) Hydropower, and (iii) Fisheries with ecological and environmental protection.

The efficiency, convenience and economy of river navigation is seriously affected by the various natural and man-made navigational hazards/hurdles such as (i) Meandering that is, too many turns in the river course (near straight reaches are most desired), (ii) Shallow depths caused mainly by silting/sediment transport/excessive fluctuations in the level and flow of the rivers (a minimum of 1.5 to 2 m depth is most desired), (iii) Erosion of Banks if the river bank and bed are not appropriately protected for their stability (widening of the river would also result in a shallower depth), and (iv) Dumping of solid wastes, oil etc. resulting in navigation machinery damage apart from unaesthetic appearance.

Therefore, navigation channels need correction and maintenance through river training civil works such as dredging, erosion control, bank protection etc. for (i) Near straight river reaches / stretches, (ii) Uniform minimum depth of 1.5 to 2 m, (iii) Stable river banks, and (iv) Rivers would become devoid of solid wastes.

River training and control works are needed for (i) Maintenance of minimum river depth through dredging, etc., (ii) Meandering control through bed vanes/spur (dikes) as long ridges of earth to canalize rivers as straight stretches, (iii) Prevention of flooding of low lying areas, (iv) Protection of roads, railways and buildings along river courses, (v) Pollution control of holy rivers affecting religious and aestheticity related sentiments (particularly control of oil pollution from leakages from oil transfer pipelines, waste oil collected in machinery spaces, accidents, boiler plants, diesel generator engines, tank cleaning, cargo oil transfer etc).

River training works are done for (i) Slope protection through masonry steps or slopping wall stretches, (ii) Stabilization of slopes through revetments (laying pebbles/growing grass on sloping banks), (iii) River bank stabilization through reinforced soil structures using double twisted polymer coated wire mesh (or green) terra mesh, (iv) Prevent shifting of banks by making structures (Groynes) in river bed to move the flow away from sides of river (also checking meandering), (v) Bandhas (dam like longitudinal structures) or gravity retaining structures (stepped *pucca ghat* type) extended horizontally into bed to avoid scouring made parallel to river flow for erosion control, control of meandering, flood protection, containment of normal flow, prevention of infiltration from either side, fool proof pollution control (*bandhas* acting as a barrier between river and town such that not a drop of wastewater would enter the river), banks of *bandhas* protected with Geomats (can be green), coir fibre Biomats (Bio mac) using combination of living material, coir fibre rolls etc. mac mat is polypropylene geomat – PVC coated double twist woven wire mesh, (vi) Weir on downstream face (vertical/sloping/stepping type), hydraulic jump controlled by secondary downstream weir, (vii) Meandering correction through small stretches to canalize river course as straight, and checking of meandering through bed vanes or spur dikes as long ridge of earth dredging.

Erosion protection for river banks, road cutting or coastal revetment as the natural erosion, an ongoing process, causes geotechnical failure in roads, rails, footpaths, etc. Use of erosion mats and soil cell for natural vegetated slopes retain soil and moisture (on rock slopes, use of wire mesh prevents rock fragments).

Erosion Mats: These promote growth on steep slopes and embankments to retain soil and moisture (roots penetrate subsoil). Natural fibre, Geosynthetic and Double twist mats are useful.

Soil cells: Cells of size 9 cells/m^2 and 10 cm deep containing pebbles are used on steep (1:1) engineering cut/ embankments. Anchorage with pins/buckles on slope is done for support and to prevent soil slumping apart from sustaining an environment for plant growth.

Rockfill Netting: On unprotected rock slopes, PVC coated double twist wire mesh is fixed to a stable slope using resin/mechanical anchors. 3-D mat or nylon filaments would trap fine material and provides anchorage for plant growth.

The aims and objectives of this Workshop include (i) Identification of the various experts available in India and (ii) The identified experts shall collaborate with Ministry Officials using data available in the Ministry for (a) Identifying various stretches needing corrections for Inland Navigation, and then (b) Suggesting practicable strategies applicable in the identified stretches of the three proposal Inland Water Ways keeping full regard of the Indian situations. This will clear way for the development and use of the three waterways.

(D.S. BHARGAVA)
Ex-Professor, IIT Roorkee

Workshop on River Training – Programme

Date: 9th May, 2008 **Venue: NINI, Gaighat, Patna**

Sl #	Time From	Time To	Programme
1	10-00	10-30	**Inaugural Session:** Inaugural address : Shri S.C. Srivastava, Member (C & F) Welcome Speech : Capt.(IN) G.S.Inda, Hydrographic Chief, IWAI Keynote address : Dr.D.S.Bhargava, Chief Resource Person Message from Chairman : Shri S.S. Pandian, Chief Engineer, IWAI
2	10-30	11-00	Tea Break
3	11-00	13-00	**Technical Session-I (20 minutes each followed by 10 min discussion)** (a) "Data collection for planning Fairway Management in National Waterway No.1 & 2 using modern surveying techniques" – Shri. G.Prasanth, JHS, IWAI, Noida. (b) "Designing of Gabion based Bank Revetment for a large river meander – A case study of River Brahmaputra" – Dr.Subasisha Dutta, IIT, Guwahati. (c) "Decision support system for integrated management of the River Ganga in Bihar" – Dr.Z.S.Tarapore, Sr.Advisor, WAPCOS (I) Ltd, Pune. (d) "Morphological interventions in the Upper Brahmaputra" – Shri. G.P.Singh, Secretary, Brahmaputra Board (e) "Use of Geo-synthetics for Bank Protection and River Training works" – Shri.Venkataraman, Garware-Wall Ropes Ltd, Pune (f) "Remote Sensing based assessment of channel instability in Ganga river inhibiting fairway sustainability" – Shri. Pankaj Kumar, IIT, Roorkee Summary of Technical Session-I
4	13-00	14-00	Lunch Break
5	14-00	16-00	**Technical Session-II (20 minutes each followed by 10 min discussion)** (g) "Training of Rivers for flood control, bank erosion and navigation" – Shri. S.K.Agrawal, Specialist (Flood), National Disaster Management Authority, New Delhi (h) "Design of River Bank Protection works" – Prof. U.C.Kothyari, IIT, Roorkee. (i) "River Bank protection along Brahmaputra near Coal Handling Terminal" – Dr. S.A.Sannasiraj, IIT, Chennai (j) "Mechanically woven Steel wire mesh crates for flexible structure on River Training" – Shri.Prashant J.Navalakha (k) "Trends in Hydrographic Data Collection" – Cdr. P.K.Srivastava, NHS, Goa (l) "Protection of Majuli Island against flood and erosion using RCC Porcupines and Spurs" – Shri. Bhagat Singh, Director (FM), CWC, New Delhi. Summary of Technical Session-II
6	16-00	16-15	Tea Break
7	16-15	17-00	**Summing up Session:** i) Recommendations ii) Vote of Thanks : Shri. N.Sivaraman, Director, IWAI, Patna.
8	19-00		Dinner

Organizing Committee

At H.O

1. Paper selection

Capt.(IN) G.S.Inda,	-	Hy. Chief
Shri T.V. Prasad	-	AHS
Shri Sandeep Kumar	-	JHS

2. Preparation of Speech and material for banner

Capt.(IN) G.S.Inda	-	Hy. Chief
Shri T.V. Prasad	-	AHS
Shri G. Prasanth	-	JHS

3. Correspondence with Regional Office/ Resource person

Capt.(IN) G.S.Inda	-	Hy. Chief
Shri T.V. Prasad	-	AHS
Shri Sandeep Kumar	-	JHS

At Patna

1. Organizing Committee (including Reception/ Invitation/Press, Comparer)

Director	-	Chairman
Principal, NINI	-	Member - Convener
A.D (Mishra)	-	Member

2. Venue committee (including arrangement of dias, sound system, Video /photo, LCD projector, banner, decoration, lamp)

Sh. A.K. Mishra	-	Asst. Director
Sh. M.K. Sharma	-	Sr. Accounts Officer
Sh. Md. Aslam	-	Supervisor (C)

3. Logistics committee (accommodation/ local transport/ food)

Sh. Gurmukh Singh	-	SHS
Sh. M.K. Sharma	-	Sr. Accounts Officer
Sh. Rakesh Kumar	-	JHS

4. Purchase committee (Seminar kits, bouquet for dignitaries/ invitees)

Sh. P.S. Rao	-	SHS
Sh. John Mathew	-	Jr. Accounts Officer
Sh. Prashant Kumar	-	Tech. Asst.

List of Participants

IWAI

1) Shri S.C. Srivastava, Member (C&F) - Chaired the Workshop
2) Shri S.S. Pandian, Chief Engineer
3) Capt.(IN) G.S. Inda, Hydrographic Chief
4) Shri Arun Roy, Director, Kolkata
5) Shri S.Dandapat, Director, Kochi
6) Shri M.K.Saha, Director, Guwahati
7) Shri N.Sivaraman, Director, Patna
8) Shri R.B.Lal, Deputy Director, Patna
9) Shri Ravi Kant, Deputy Director, Noida
10) Shri Gurmukh Singh, Senior Hydrographic Surveyor, Patna
11) Shri VVP Singh, Assistant Director, Bhagalpur
12) Shri D.Kumar, Assitant Hydrographic Surveyor, Allahabad
13) Shri Ram Nath, Assitant Hydrographic Surveyor, Farakka
14) Shri V.N.Mishra, Assistant Director, Allahabad
15) Shri A.K.Mishra, Assistant Director, Patna
16) Shri P.S.Rao, Assistant Director, Patna
17) Shri M.K.Sharma, Senior Accounts Officer, Patna
18) Shri Sayed Javed, Section Officer, Patna
19) Shri A.K.Gulati, Junior Hydrographic Surveyor, Bhagalpur
20) Shri G.Prasanth, Junior Hydrographic Surveyor, Noida
21) Shri Rakesh Kumar, Junior Hydrographic Surveyor, Patna
22) Shri Shiv Murthy, Junior Hydrographic Surveyor, Varanasi
23) Shri Prashant Kumar, Technical Assistant, Patna
24) Shri S.K.Shukla, Junior Hydrographic Surveyor, Patna
25) Shri Sandeep Kumar, Junior Hydrographic Surveyor, Noida
26) Shri John Methew, Junior Accounts Officer, Patna

Resource Persons

1) Dr. D.S. Bhargava, Prof. Ex-IIT Roorkee - Chief Resource Person
2) Er.S.K.Agarwal, Ex-CWC Member - Chairman, Tech. Session-I
3) Dr. Z S Tarapore, Sr.Advisor, WAPCOS - Chairman,Tech. Session-II
4) Shri G.P.Singh, Secretary, Brahmaputra Board
5) Shri Bhagat Singh, Director (FM), CWC
6) Cdr. P.K.Srivastava, NHS, Goa
7) Dr. U C Kothyari, Professor, IIT Rorkee
8) Dr. Subasisha Dutta, Associate Professor, IIT Guwahati
9) Dr. S A Sanrasiraj, Associate Professor, IIT Chennai
10) Mr. Pankaj Kumar, Research Assistant, IIT Roorkee
11) Mr. M Venketraman, G.M., M/s Garware-wall Rope Ltd, Pune
12) Mr. Prashant Navalakha, DGM, M/s Maccaferri Solutions Pvt. Ltd, Mumbai

Others

1) Shri D.V. Theraja, Chairman, GFCC, Patna
2) Capt. A.P.Mascarenhas, Capt. of Ports, Goa.

TECHNICAL SESSION - I

"Data Collection for planning fairway management in National Waterway-1 & 2 using Modern Survey Techniques"

(G.Prasanth, JHS, Inland Waterways Authority of India, Noida)

ABSTRACT

The Government of India has constituted Inland Waterways Authority of India in the year 1986 for development, maintenance and regulation of National Waterways for shipping and navigation. So far, Govt. of India has declared three waterways as National Waterways (NWs) viz:

a) Allahabad- Haldia stretch (1620 km) of the Ganga- Bhagirathi-Hooghly river system as National Waterway No-1 (in the year 1982)
b) Sadiya- Dhubri stretch (891 km) of Brahmaputra river as National Waterway No-2 (in the year 1988) and
c) Kottappuram- Kollam stretch of West Coast Canal alongwith Champakkara canal and Udyogamandal canal (205 km) as National Waterway No-3 (in the year 1993).

IWAI is developing these National Waterways in a phased manner. Other than this, IWAI is maintaining Least Available Depth (LAD) ranging from 1.5 m (minimum) to 3.0 m (maximum) depending upon capacity of vessels 300 to 500 tones ply in these waterways.

The paper indicates various methods used by IWAI for data collection in NWs using modern survey equipments viz. AHSS system consisting of Laptop with Hypack Max software, Digital Echo-sounder, GPS / DGPS, Sub Bottom Profiler, Side Scan Sonar, Acoustic Doppler Current Profiler (ADCP), Water & Bottom Sampler, HF / VHF set etc. and how such data being used for planning and executing fairway development work on NWs. Even then, IWAI encountered problems due to the peculiar nature of NWs, in particular the Ganga and the Brahmaputra. The only solution for making a stable and navigable fairway in NW-1 & NW-2 is by executing appropriate river training works. In this direction, IWAI is ready to share its vast data bank with the experts / agencies who are ready to take up this challenging task. The data bank include LAD data, shoal analysis, data on water an sediment samples, discharge data, Water level data, satellite images, SOI toposheets, river navigational charts etc.

DESIGNING OF GABION BASED BANK REVETMENT FOR A LARGE RIVER MEANDER: A CASE STUDY FOR RIVER BRAHMAPUTRA

S DUTTA, TAPAS KARMAKER, S SREEDEEP AND SUJIT K. DASH

ABSTRACT

In river Brahmaputra, designing of an appropriate river bank protection work has been a challenging task for engineers. This is due to large physical dimension of the river and limited hydraulic study conducted. It is a braided river system with flood channel width varying 3-15 km and frequent flood events change its morphologic characteristics (Garg, 1989). Besides this, in a river meander, there is formation of secondary current, accelerating the bank erosion rate. Inland Waterways Authority of India (IWAI) has planned to construct a terminal on the bank of a river meander at Jamuguri, Assam. The terminal needs an efficient river bank protection for which IIT Guwahati conducted a detailed hydraulic study.

In this paper, we describe the procedure adopt for designing an effective river bank revetment system with due consideration to complex hydraulics of a large river meander. The work is divided into three major steps: morphological study using satellite imagery, hydrodynamic study using a well-known mathematical river model and designing gabion mattress for river bank revetment.

A detailed hydraulic study using the mathematical river model has been conducted for a river meander of the Brahmaputra. The hydraulic study has predicted zone of the bank erosion, maximum striking velocity during extreme flood condition with/without upstream bank erosion and flow depth variation. Using the geometrical characteristics of the river meander, maximum souring depth has been computed. After obtaining these hydraulic data, gabion mattress has been designed by following the recent design practices. Since the bank is vulnerable to significant sliding forces due to secondary current, a suitable anchorage system for the gabion mattress has been designed for strengthening the bank revetment system.

DECISION SUPPORT SYSTEM FOR INTEGRATED MANAGEMENT OF THE RIVER GANGA IN BIHAR.

Dr.Z.S.Tarapore, Sr.Advisor, WAPCOS (I) Ltd.

ABSTRACT

The River Ganga, known as the Bhagirathi upto Devprayag, has its source in the Gangotri glacier in Uttaranchal. Other streams which join the Bhagirathi, along its course are the Bhilangana, Mandakini, Pindar, Alakananda and Dhauliganga. While flowing through Uttar Pradesh, the Ganga receives the waters of the Ramganga, Yamuna, Tons and Gomti, before entering the State of Bihar. In Bihar, the major tributaries are the Ghagra, Sone, Gandak, Punpun, Kosi, and Mahananda. Most of these tributaries enter from the north and the behaviour of the general river system results in a series of inland deltas and erosion sites which make the Ganga and its tributaries a morphologically, highly active system.

A number of studies on the behaviour of the river system have been carried out by various Committees, studying different reaches of the system in the States of Uttar Pradesh, Bihar and West Bengal. In addition, a major study of navigability in the river Ganga from Farrakka to Allahabad was undertaken with the assistance of the Government of the Netherlands.

The river reach of the Ganga, within the State of Bihar, is marked by a multiplicity of channels which are active at different periods of time. The sediment load carried by the river is such that the river tends to meander between its deposits in the flood plain.

Bank protection measures have been provided in different reaches in order to contain the river within the flood protection embankment. Since morphological changes or changes in flow pattern at one location in the river affect the entire reach to the downstream, and to some extent upstream, any site specific river training work has to be considered in a global manner, so that problems of one reach are not transferred to another.

There are four reaches of the Ganga viz Buxar Bridge - Keshopur, Neknamtola, Hasanpur - Dhamaun, Bajalpur – Amarpur – Mokameh Bridge within the State of Bihar, between Buxar and Mokameh, which need consideration in a broader perspective, examining not only the effect of river training works for bank protection, but also the requirements of navigation.

It would be quite clear that the State of Art knowledge in the field of hydraulic modelling needs to be brought to bear on the problems of bank protection of the Ganga in Bihar.

The State of Art on "River Behaviour, Management and Training" has been brought out in a classic manual by the Central Board of Irrigation and Power, based primarily on the research carried out by the Central Water and Power Research Station, over several decades. This volume was first produced in 1956 and revised in 1971 and 1989.

In conclusion the another has recommended to: -

- Review existing procedures for maintenance and development of the waterway with a view to suggesting improvements and coming up with revised procedures
- Review the existing procedures for hydraulic/ morphological analysis and upgrade these facilities with state of art modelling tools, such that the planning and development of the inland waterway is consistent with the needs of bank protection and other users, such as domestic and industrial water supply
- Review the present data collection programme and introduce new data collection schemes intended to meet the inputs required for hydraulic/ morphological modelling
- Set up a dedicated data base for the use of planners, which would be utilised as an on-line tool for predicting the need for dredging and bank protection well in advance, thus introducing new river system maintenance tools
- Involve the use of other disciplines such as Remote Sensing and GIS to improve the value of both the morphological analysis and the dedicated data base
- Set up a Decision Support System for use of planners connected with the river conservancy system.

MORPHOLOGICAL INTERVENTIONS IN THE UPPER BRAHMAPUTRA: A SUCCES STORY OF THE BRAHMAPUTRA BOARD

BY

Shri Rajan Nair, Chairman, Brahmaputra Board	*Shri G.P.Singh, Secretary, Brahmaputra Board*	*Shri D.N.Kalita, Asstt. Xen, Brahmaputra Board*

ABSTRACT

Bank erosion is a natural phenomenon associated with the channel formation characteristic of large braided rivers like the Brahmaputra. But at times, human intervention becomes necessary to offset major economic losses and sufferings of the people. The Rohmoria area near Dibrugarh has caught the attention since 1997 due to the large-scale erosion that has been going on. Morphological studies revealed that one of the major causes of such massive erosion lied elsewhere – near Dholla-Hatighuli area where avulsion of the Brahmaputra took place through a small channel called Anant Nalla which grew year after year ultimately qualifying itself to be one of the channels of the Brahmaputra itself and thus forming a large island in between. A major morphological intervention has been proposed and the Brahmaputra Board is presently executing the project. Three of the four phases have been completed so far since January 2003 and the results have been found to be encouraging.

After a detailed study of the river configuration, the Brahmaputra Board took up the diversion of the river Dibang at Dholla from its north-south course to a course parallel to the flow direction of the Lohit and thus reduce the pressure on the Lohit river at Hatighuli. It was decided that RCC porcupines and locally available material like bamboos and wood will be used instead of costly techniques.

PHASE-I

The first phase of the work was taken up in January, 2003 and completed in mid-April at a cost of Rs.6.5 crore. The flow of water was adequately controlled.

PHASE-II

The works taken up under this phase was aimed to divert the flow of Lohit towards further north to meet Dibang.

The components of Phase-II works are as follows :

1. Construction of permeable of RCC porcupine screens across the river Lohit from down stream of Dhollaghat to new channel of Dibang.
2. Construction of pilot channel to guide the flow of Lohit to meet new Dibang channel.

Due to the Phase-II works, considerable amount of flow of Lohit river during flood period could be diverted towards the north of Saikhowa Reserve Forest. In the reach from Sisini to down stream of Dhollaghat, the deeper channel of the river shifted towards north. Siltation took place near the Dhollaghat area and the flood channel off

taking from Sisini almost silted up.

PHASE-III

For further improvement of the diversion of the rivers towards north, proposals under Phase-III in the line of recommendation of the Joint Inspection Team after their visit to site on 10th to 13th of December, 2004 were prepared.

PHASE-IV

For further diversion of river Lohit to its original course and to reduce/stop flow along the offtake channels (Anant Nalla, Balu Nalla), it is now proposed to take up the Phase-IV works during 2008-09. It is proposed to construct sand-filled geo-synthetic tube at the downstream of the proposed diversion channel along with RCC porcupine screens in the upstream for diversion of river. In this regard an estimate is being prepared.

The success of the project so far has raised the hopes of the local people and also the confidence of the Brahmaputra Board in tackling such major morphological interventions. It also shows that erosion control in a major braided river system such as the Brahmaputra cannot be a local affair, rather it should be conceived in a global manner with a long term strategy.

USE OF GEO-SYNTHETICS FOR BANK PROTECTION

BY
MR. M.VENKATRAMAN, G.M., GARWARE ROPES PVT. LTD.

ABSTRACT

Geo-synthetics are replacement of conventional construction material. They achieve continuity and longevity of the structure since they are flexible in nature. Energy dissipation is the basic principle in all these structures. Mostly the locally available material is used in conjunction with the geo-synthetic material for protection. To deepen navigation channel dredging and appropriate encapsulation of dredged material for protection of banks is possible with Geo-synthetics.

Presently in India polymer products are being used in various coastal protection works and in beach reclamation structures such as sea walls, bulk heads, break waters and groins. As Geo-synthetic products proved their ability, river training structures also can adopt these materials. Geo-synthetic products have more advantages in comparison to traditional alternatives.

Products used in river training works

1. *Geo-textile* – Available in woven and non woven types. For filtration purpose generally woven geo-textiles are used. .
2. *Sand mattress* – Sand sandwiched and stitched between two geo-textiles used as cushion material
3. *Gabions* – Boxes made of PP rope or PVC + Zn coated steel used mostly in erosion protection works.
4. *Geo-systems* – Sand filled containers made in box, pillow and in tube shape which are used in various applications. These are custom made, can be stitched in any required dimensions.
5. *Garmat* – Used to stabilize and beautify country side slope of embankments.

The field efficacy of the geosynthetic materials have been proved all over the world. In India large number of structures for river and coastal works have been executed and under execution. Currently the WRD 22 has also taken necessary steps and consequently draft code for design of groynes which is IS8408 and for revetment using gabion mattress as a replacement to loose stone pitching and crates hand made steel crates are under preparation and expected to go for wide circulation.

Remote Sensing Based Assessment of Channel Instability in Ganga River Inhibiting Fairway Sustainability

Pankaj Kumar[1], Anupama Nayak[2], Nayan Sharma[3], R.D.Garg[4]

ABSTRACT

Water based transport is generally effective in terms of low operating fuel cost and the lower risk of environmental pollution as compared to corresponding transportation by road, rail or air. A major advantage is that main infrastructure in the waterway is often naturally available which is then has to be trained and upgraded (Ranagraj N., 2006). More even the order of ratio between water, railway and road transportation is with in the range of 1:2:5 in cost and 1:1.5:4 in energy consumption. So this mode of transport continues to be a very effective mode for transportation of bulk products in developed countries of Europe and America. In some developing countries, land routes are non existent in some areas and the simple roads or rails that do exist are inadequate for commercial transportation especially in rainy season (Osman A.K., 1988). In such areas, inland waterways are extremely important as transport routes of people and supplies. Improved commercial waterways transport can support the economic development of a region and therefore of a nation. The technological and physical viability of inland waterways transport sector depends on the adequate development of waterways for navigation in terms of stability and safety (Jansen P.P., 1979).

This remote sensing based study for the assessment of navigation channel changes has been carried out at six different key locations on Ganga River. For determining the changes in bank line and width of the Ganga River, multi temporal satellite data sets have been procured for the two different years 2005 and 2007. For 2005 year, IRS-1D PAN data with 5.8 m spatial resolution was taken due to its high resolution capability while for 2007 year IRS-P6 LISS III with 23.5 m resolution and IRS-P6 LISS IV data with 5.8 m resolution has been utilized due to their multispectral and high resolution information content. The present study has been carried out over six different locations on the Ganga River viz. Bateshwarsthan (at chainage 683), Punarak (at chainage 8799), Digha (at chainage 976), Arjunpur (at chainage 1118), Deochanpur (at chainage 1247), Nakhwa (at chainage 1299).

The stability and the width of the channel are the important factors which affects the navigation. At the six important navigation bottleneck sites, significant channel instability processes have been observed from the satellite images. Analysis was done by estimating the offsets to the left and right bank with respect to two years.

TECHNICAL SESSION - II

Training of Rivers for Flood Control, Prevention of Bank Erosion, Maintenance of Navigation Channels

S.K.Agarwal, Specialist (Floods) and Former Member (RM), CWC

ABSTRACT

The paper describes that 40 million hectares out of a geographical area of 329 million hectares is prone to floods. On an average 75 Lakhs hectares of land is affected, 1600 lives lost and damage caused to crops, houses and public utilities is of the order of Rs.1805 Crore every year due to floods. The frequency of major floods is more than once in five years. Floods have also occurred in areas which were earlier not considered flood prone.

Other than this, paper explains the definition of River Training – "a technique to achieve desired course, shape, width and depth of the river" and demonstrates the objectives of river training in National Waterways: -

- Prevention of flooding
- Prevention of river bank erosion for protection of towns, cities, villages, monuments, strategic, industrial, commercial structures and agricultural land etc.
- Protection of hydraulic structures - bridges barrages, dams etc.
- Maintenance of navigation Channels
- Reclamation of land

It describe various methods of hard river training measures such as revetment, impermeable spurs, embankments, guide banks and dredging and soft measures like permeable spurs, permeable embankments and submersible spurs or bed bars. It also gives details of modern river training measures like RCC porcupines, geo-bags filled with sand, flexible mattresses & bamboo / wood porcupines; its advantage and disadvantages.

The importance of mathematical modeling in river training is highlighted in this presentation. Guidelines on Flood Management formulated by the National Disaster Management Authority (NDMA) on 17.01.2008 also covered in this paper.

DESIGN OF RIVER BANK PROTECTION WORKS-CASE STUDIES

BY

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ABSTRACT

Rivers in alluvial plains are highly variable in their behavior and to an average man often unpredictable. A stream, which is quite trouble free during low flows, attains a threatening condition during high stages. It can develop unforeseen meanders, break through embankments, attack towns and important structures, outflank bridges and in general may create havoc. Therefore whenever the river is to be used for the pupose of inland navigation and/or any hydraulic structure is built across an alluvial stream, adequate measures in the form of river training works must be taken to stabilize the river course along a certain alignment with a pre-determined cross section. All these works, which are constructed to train the river, are known as river training works. Various types of river training works are provided (Sharma and Ashthana, 1976). However, in the present paper salient design features for permeable spurs are discussed. Design considerations for examining the stability of permeable spurs during high flood conditions have been identified. Authors were involved in suggesting remedial measures in the form of permeable spurs to prevent serious bank erosion on the banks of the river Ganga near Garhmukteshwar railway bridge and near Balawali railway bridge in U.P. as well as on the bank of river Deha in Barreilly, U.P. The performance of the permeable spurs for controlling and protection of the river bank as per field observations is presented in this paper.

The permeable spurs as river training and bank protection works could be designed as per the recommendations and procedure given in sections 2 and 3. Stability of permeable spurs needs to be ensured so that they serve the intended purpose of bank protection during the flood. Performance of permeable spurs as suggested for the railway bridge at Garhmukteshwar and Balawali on the river Ganga and at Bareilly on the river Deoha clearly demonstrated their suitability for bank protection.

RIVER BANK PROTECTION ALONG BRAHMAPUTRA NEAR COAL HANDLING TERMINAL

Prof. V. Sundar and Dr. S.A. Sannasiraj

ABSTRACT

Inland Waterways Authority of India (IWAI) is developing and managing the National Waterways No.2 891 km of the river Brahmaputra. The authority has identified, Jogighopa one of the prominent terminal point a floating terminal at Jogighopa for coal handling. Jogighapa is situated at 90°34'10"E and 26°13'20" N. IWAI had received a proposal from Kolkatta Port Trust (KoPT) and M/s Garware Wall Ropes Ltd for protection of river bank at the recommended location using geo-textile filter, RCC toe wall geo-bags, geo-containers and polymer rope gabions. The concept of using geotubes and related materials is new in the waterways and near alluvial river like Brahmaputra which is having high velocity and water level variation. In this connection, Department of Ocean Engineering, Indian Institute of Technology – Madras, carried out a detailed analysis on both proposals as IITM had involved in using shore protection works using geo-tubes.

The bank protection measures for the terminal area had taken up at Jogighopa by IWAI. The Kolkatta Port Trust (KoPT) has suggested bank protection work by providing geo-tube over geo textile filter and RCC toe wall. M/s Gareware wall Ropes Ltd has also given a proposal for protection of river bank at the same location using geo-containers, geo-bags and polymer rope gabions. The technical viability of both the proposals has been analysed by IIT Madras and suitable improvements over the above designs have been suggested.

Both GWRL and KoPT have recommended bank protection system with components of geotubes and geocontainers. It is recommended to provide the solution without the rubble stones to avoid any possible blockage of proposed terminal way. Hence, the proposal of GWRL can be considered after redesigning the anchoring system for sand mattress and geocontainer layer.

MECHANICALLY WOVEN STEEL WIRE MESH GABIONS AND MATTRESSES AS FLEXIBLE STRUCTURE FOR RIVER TRAINING

(By *Maccaferri Environmental Solutions Pvt. Ltd.)*

Ashish Gharpure
C.O.O

Minimol Korulla
GM – Design and Head of WDC

Prashant Navlakha
DGM - Technical Design

Shabana Khan
Dy. Manager-

ABSTRACT

River Training is an age old practice resulting in incessant development and application of human ingenuity to correct vagaries of the rivers. It requires deep and precise study of river mechanism and behaviour. River training has assumed considerable significance in India due to huge annual recurring damage caused by the floods.

The paper attempts to highlight the requirement of river training works, followed by the different river training structures that can be constructed using mechanically woven steel wire mesh products such as Gabions and Mattresses.

Structures made with Gabions and Mattresses are durable, simple to construct and cost effective. Their flexibility and self draining characteristics make them preferable to other types of materials in the construction of water front structures. The porous nature allows vegetation to take its roots through these structures which will make them more stable and environmental friendly. With the passage of time, the siltation will increase the gravity behaviour of the structures which will further enhance the stability of the system.

River improvement schemes always need careful consideration and a scientific as well as practical approach.

Among the different types of structures for river and coastal bank protection, flexible structures like gabions and Reno mattresses have many advantages which make them popular world wide.

With the broad range of Double Twisted wire mesh products effective, long lasting, eco friendly structures can be economically build for river-training works.

TRENDS IN HYDROGRAPHIC DATA COLLECTION

Cdr. P.K.Srivastava, NHS, Goa

ABSTRACT

The sea, often called the "great common" constitutes about 70% of the Earth's surface, and over 2/3 of the world's population lives within 100 miles of it . Since creation, man has been making use of the sea mainly for transits, transport trade and in search of food. Most of the voyages made by the early men, in an attempt to satisfy their need were either too long or ended up in disasters mainly due to the lack of the knowledge of the sea. It was extremely difficult then, for them to know their position as well as the portion of the sea, where their boats can safely navigate. These problems prompted the early men to acquire the knowledge of the sea and its environment. The science of hydrography therefore originated in the need for the production of ocean maps specially designed to meet the mariners need at sea.

Since the early ages man has been trying to fathom the unknown treasures and the dangers lying beneath the surface of the seas. In his quest for finding the mysterious assets and threats he has been trying to develop new techniques of observation and mastering them. Preparing the charts has been one of the process of retaining the knowledge gained over the generations. In order to print a chart and collect data for the same, there are several techniques which have been evolved since the olden times.

The history of nautical information generation can be traced back to the earliest days of navigation. In the beginning, such information used to be passed on orally; however, first written records date back to antiquity. In the Odyssey, the reader will find quite a number references to the sailing directions. The first navigational charts in history are considered to be the Portulan charts from the 13th century. The beginning of hydrographic services in the modern sense of the word was much later, in the 17th and 18th century. Closer co-operation for hydrographic services amongst nations for safety of life at sea began in the late 19th and early 20th century.

Beginning with the improvements made to wiredrag in the early 20th century, the hydrographers have been developing techniques and methods of data collection in order to improve our ability of understanding the nature of the seafloor. The modern technological breakthroughs that provided multibeam sonar, along with improvements in data processing and DGPS positions, had a revolutionary impact on the quality and amount of hydrographic surveying. The hydrographers who were instrumental in developing the procedures for using these systems and advancing the art of hydrographic and bathymetric surveying should be praised for their dedicated efforts. Today's modern hydrographic surveys provide a complete high resolution "picture" of the seafloor that can be used for marine navigation, resource mapping, fisheries and coastal zone management. These new and accurate forms of hydrographic data collection have enabled the mariner to now move from the traditional paper chart to the age of Electronic Navigation Charts (ENC). Electronic charts are the next generation of navigational charts, and can enhance safety of navigation through improved situational awareness, especially in busy or confined waters.

Protection of Majuli Island against Flood & Erosion Works using RCC porcupines screens and spurs – A Case Study

Bhagat Singh, Director (FM-II), CWC

ABSTRACT

The Majuli Island is the largest inhabited riverine island in the world and seat of 15th century Vaisnavite culture and religious traditions. The island is located in the upper reaches of the river Brahmaputra between intake point of Kherkatia-Suti in East and outfall of Subansiri river in the West in Jorhat district of Assam. The island extends for a length of about 80 km along the East West and about 10 to 15 km wide along North South direction. The most important problem that threatens the very existence of this island and the life and property of its inhabitants is the constant and extensive erosion of land by mighty Brahmaputra, the Subansiri and Kherkatia-Suti. The island is reported to be under sever erosion since 1950, when a major earthquake occurred in the region. It has lost about 370 sq. km. of its area due to flood and erosion since then.

The state Govt. had taken some short term measures in the form of embankments, land spurs, permeable spurs etc. Though these measures provided some protection against erosion and inundation but it could not stop the continuing loss of landmass. On the request of the State Government, the Brahmaputra Board invited a team of experts for inspecting the main erosion spots in the island, investigating cause of erosion, drawing short, medium and long term measures to effectively combat erosion in systematic manner.

Based on its recommendations, the Brahmaputra Board has taken various protection measures during the last five years which are comparatively inexpensive and have checked the erosion and resulted in silting in vulnerable reaches.

The paper gives an overview of the problem, measures adopted comprising RCC porcupines screens, spurs etc.

Proceedings and Recommendations of Workshop on "River Training Works" in National Waterways (NWs) held at NINI, Gaighat, Patna on 9th May, 2008

1. Aim of the Workshop

The Workshop on "River Training Works" in National Waterways (NWs) was organized by Inland Waterways Authority of India (IWAI), Ministry of Shipping, Road Transport & Highway on 9th May, 2008 at National Inland Navigation Institute (NINI) at Gaighat, Patna.

Among about 50 participants, there were officials from Central Water Commission (CWC), Brahmaputra Board (BB), Water and Power Consultancy Services (I) Ltd. (WAPCOS), National Hydrographic School (NHS), Ganga Flood Control Commission (GFCC), Captain of Ports, Goa, Professors from IIT Roorkee, IIT Chennai, IIT Guwahati as well as representatives from industries viz. M/s Garware-wall Ropes Ltd & M/s Maccaferri Solutions Pvt. Ltd.

The aim of this Workshop was to discuss various methods of river training works in India and abroad. The following topics were presented, discussed and delibrated during the Workshop: -

(i) Data collection for planning Fairway Management in National Waterway No.1 & 2 using modern surveying techniques.
(ii) Designing of Gabion based Bank Revetment for a large river meander – A case study of River Brahmaputra.
(iii) Decision support system for integrated management of the River Ganga in Bihar.
(iv) Morphological interventions in the Upper Brahmaputra.
(v) Use of Geo-synthetics for Bank Protection and River Training works.
(vi) Remote Sensing based assessment of channel instability in Ganga river inhibiting fairway sustainability.
(vii) Training of Rivers for flood control, bank erosion and navigation.
(viii) Design of River Bank Protection works.
(ix) River Bank protection along Brahmaputra near Coal Handling Terminal.
(x) Mechanically woven Steel wire mesh crates for flexible structure on River Training.
(xi) Trends in Hydrographic Data Collection.
(xii) Protection of Majuli Island against flood and erosion using RCC Porcupines and Spurs.

2. Conduct of the Workshop

The Workshop was opened by the welcome speech of Capt. (IN) G.S.Inda, Hydrographic Chief, followed by Keynote Address by Dr. D.S. Bhargava, Ex-Professor, IIT Roorkee, who summarized the objectives of the Workshop. Later on Inaugural Address was delivered by Shri S.C. Srivastava, Member (Cargo & Finance) IWAI followed by Message of Chairman, IWAI read by Shri S.S. Pandian, Chief Engineer.

The Workshop's general theme was divided into six sub-topics, which are as follows: -

a. Closure of secondary channels using low cost materials.
b. Bank protection in Ganga and Brahmaputra rivers.
c. River training works using porcupine and spurs etc.
d. Dredging and Bandalling, as methods to contain channel.
e. Hydrographic data collection.
f. Use of Geo-synthetic or any other material for bank protection and river training works.

These sub-topics were discussed and deliberated during the two consecutive technical sessions, through paper presentation by eminent resource persons. On completion of each presentation from invited resource person, a sufficient time was allotted for open discussions, in the Workshop. There was a very positive response from the learned audience and resource persons on the topics discussed and way ahead in improving fairway management of National Waterways using latest River Training Works. The Workshop concluded with panel discussions on the recommendation of each technical session and final recommendation to be considered by IWAI.

3. Technical Session – I

Technical Session – I was Chaired by Er. S.K.Agarwal, Ex-Member, CWC & now Consultant (Floods), National Disaster Management Authority. The proceedings of the session was recorded by Er. M.K.Saha, Director, IWAI, Guwahati.

In all six technical papers were presented in this session. The summary of the contents of the papers discussed are as under: -

(1) Data collection for planning fairway management in National Waterway 1 & 2 by Shri G.Prsanth, JHS, IWAI.

Brief on National Waterways, methodology for collection of data, availability of source data for planning river training works was presented in exhaustive way. Through the presentation a detailed description of various types of Bathymetric, hydrological and geomorphological data available / being collected by IWAI's Hydrographic Wing was highlighted.

This was a very useful presentation in the sense that academician, IWAI & industries think tank can work together to plan Fairway management through research, design & implementation of structures for various river training works, for safe and better navigation in NWs.

During discussion it was suggested that these data should be made available for research & design of various works. Hydrographic Chief clarified that LAD is available on IWAI's website and other bathymetric data is available in digital format with IWAI and can be made available on exchange / payment as decided by Competent Authority.

(2) Designing of Gabion based Bank Revetment for a large river moander - A case study of Brahmaputra by Dr. S.Dutta & others IIT Guwahati.

This is first comprehensive study of Brahamaputra for locating port and developing structures to prevent for the erosion. The study has analyzed the problems of formation of shoals in entrance channel with the aim that IWAI can plan proper maintenance dredging. The resource person brought that lot of efforts have been put in by their team but calibration of the model could not be done satisfactorily due to limited data collected over a small reach selected for

study. However, it was opined that works based on the study can be implemented after review by a technical committee.

(3) Design Support System (DSS) for integrated management of the river Ganga in Bihar by Prof. Z.S.Tarapore, WAPCOS.

The paper was based on the vast experience of the resource person in river engineering & hydraulics as the author was Ex. Director of CWPRS & has been associated with various studies of NWs. He had analyzed the problem of erosion along Ganga in Bihar. The Design Support System (DSS) for management of all aspects of Water Resource (WR) development i.e. irrigation, Water Supply (WS), agriculture & navigation was recommended to be developed. He further stressed that detailed analysis of particular stretch can be carried out for specific purpose, be it navigation, erosion or flood control. Remote Sensing (RS) and Geographic Information System (GIS) are very important tools for collection and analysis of data and should be made use for developing Mathematical models (1D, 2D or 3D) depending upon specific needs.

(4) Morphological interventions in the upper Brahmaputra: A Success story of Brahmaputra Board (BB) by Sh. G.P. Singh & Others of B.B.

It analyses problem of avulsion of the rivers Brahmaputra, Debang & Lohit Anant Nala and efforts made by Brahmaputra Board in solving the problem in an innovative way of adopting a new technology of RCC porcupines. The experiment has been successful and evolved over last 4-5 years. There can be many more innovations employing RCC porcupines and conflict between bank erosion and navigation can be solved by interacting the concerned agencies (in BB & IWAI) each other. This has low cost potential of solving the problem and can be of great help in navigation, as it offers a cheap method of closing secondary channels & guiding the flow into the main channel. During interactive session lots of probing questions were asked by the audience on its sustainability, effect on channel condition, removal of RCC porcupines etc.

(5) Use of geo synthetics for bank protects and RTW by Shri M. Venkataraman, M/s Garware-Ropes Pvt. Ltd.

The use of geo synthetics in various forms for various purposes such as bank protection, anti-sea erosion and RTW was described in a professional way. It is a promising technology and need to be adopted for experimental purposes for efficient & eco-friendly solution. During the interactive session it was suggested that its impact on health of the people and effect on environments needs to be evaluated. M/s Garware has agreed to suggestion to conduct some test to assess its impact.

Director, IWAI, Kochi informed the audience that Geo-synthetics have been used in the NW-3 and it had no adverse effect on environment, pollution etc.

(6) Remote sensing based assessment of channel instability in Ganga River inhibiting fairway sustainability by Mr. Pankaj Kumar & others of IIT.

Use of Remote Sensing technology for assessing changes in plan forms of the channels was described by giving an example of the study of Ganga river for

IWAI. In fact this is the most promising technology which has application in all fields including water resources management. However, Remote Sensing techniques using satellite imageries need to be referenced with Ground Control Positions (GCPs) for accurate study, designing of River Training Works & positive Fairway development in the NWs. IWAI can help in identifying / establishing GCPs required for the NWs for effective results.

Recommendations of Technical Session - I

The Chairman of Technical Session – I gave the recommendations of the session chaired by him as follows: -

1. The data collection needs to be rationalized and done with latest technical innovations to have reliability.
2. All data collected should have inventories and a data bank with proper system of storing and retrieval need to be developed.
3. Suspended sediment load should also be measured by IWAI by laser sensor.
4. Mathematical model studies are very useful for analyzing the problems but the reliability of the results depends upon data used and calibration of model. They have the inherent advantage over physical models that they are cheaper and studies can be completed in a short period. Simpler version like one dimensional model should be used for entire navigable length of the rivers and 2D or 3D models for detailed study of specific reaches / locations.
5. Emphasis should be given for development of a comprehensive DSS integrating all aspects of water resources i.e. water supply, irrigation, flood control, bank protection and navigation as these are inter dependent.
6. R.C.C. porcupines is an innovative approach of tackling the problem of bank erosion evolved jointly by Brahmaputra Board , CWC & CWPRS and need to be developed further for river training works in IWAI for various purposes as it is comparatively cheaper, easy to construct & maintain. RTW should be taken up after proper interaction between all the stakeholders i.e. water resources Irrigation Dept. of States, GFCC / Brahmaputra Board and IWAI so that their efforts on river training compliment each other rather than be in conflict.
7. Use of geo-synthetics in bank protection is getting popular because of speed of construction and the fact that they envisage use of river bed materials extraction of which can be planned in such a way so as to guide the flow to the desired channels. Though costly in initial investment, it may prove to be economical in long run. Techno-economic analysis of various options need to be carried out before finalization. M/s Garware will study if the geo-fabrics have any affect on water quality, environment, health hazards etc.
8. Remote sensing technology has wide application and when integrated with GIS it becomes an important tool for collection of reliable data and analysis for various purposes. Study of changes in platform of the river can be most reliably & economically studied using satellite imageries. This should be increasingly used in river studies. For better accuracy Geo-referencing of Satellite imageries with Ground Control Positions (GCPs) is recommended.

9. A Technical committee may examine recommendations made in the study carried out by Dr. S.Dutta and his colleagues for protection of inland port on bank of Brahmaputra and adopt the measures with appropriate modifications as it is felt that there can be some saving in cost without affecting its performance. IWAI has also to plan for maintenance dredging for the entrance channel to the port.
10. A group of experts should be set up by the IWAI to examine feasibility of adopting RCC porcupines with appropriate changes in design depending upon site specific conditions for closure of spill channels / secondary channels and guiding the flow into navigation channel for achieving required depth of water.
11. There should be reach wise committees to integrate river training measures for navigation channels into the measures required for bank protection / flood control to have a long term solution of the problem. The committee should have representatives of CWC, GFCC, Brahmaputra Board, State Govts. and IWAI and should meet regularly.

4. Technical Session – II

Technical Session – II was Chaired by Dr. Z.S. Tarapore, Ex-Director, CWPRS & now Advisor, Water & Power Consultancy Services (India) Limited (WAPCOS). The proceedings of the session was recorded by Er. Arun Roy, Director, IWAI, Kolkata.
In all six technical papers were presented in this session. The summary of the contents of the papers discussed are as under: -

(1) Training of Rivers for flood control, bank erosion and navigation by Shri S.K.Agarwal, Ex-Member, CWC.
Shri S.K. Agrawal, Former Member (River Management) Central Water Commission presented an excellent summary of river training measures required with the objectives of: -

- Prevention of flooding urban industrial and rural agricultural lands
- Prevention of river bank erosion
- Protection of structures such as bridges and barrages
- Maintenance of navigation channel – an area of importance to IWAI
- Reclamation of land

Acting the role of mathematical models in river training and the guidelines on Flood Management, put out by the National Disaster Management Authority in January 2008, were highlighted by the resource person as follows: -

- Mission to minimize vulnerability to floods and consequent loss of lives, property and damage to infrastructure and public utilities.
- All aspects of flood management including anti-erosion measures and dredging of river.
- Mathematical and Physical model studies for flood management works including embankments, spurs, revetments by Central and State Governments to develop eco- friendly and cost-effective measures.

(2) Design of River Bank Protection works by Prof. U.C. Kothiyari, IIT Roorkee.

Prof. Kothiyari presented the results of a basic study carried out at IIT Roorkee to determine forces on a permeable spur as a function of blockage ratio, in order to ensure stability of the structure against river current. During the presentation it was suggested that further work could be undertaken for the interference effects of groups, and also for other forms, such as porcupines.

(3) River Bank protection along Brahmaputra near Coal handling terminal by Prof Sannisiraj, IIT Chennai.

The paper presented by Dr. Sannasiraj of IIT Madras contained a comparison of two alternative designs for river bank protection work at Jogighopa, which brought out undesirability of a rock toe at river bank revetments, which endangered navigation.

(4) Mechanically woven Steel wire mesh crates for flexible structure on River Training by Shri Prashant J. Navalakha, M/s Maccaferri Soultions Pvt. Ltd.

The paper presented by Sh. Navalakha of Maccaferri was on the use of wire mash gabions for river training. Various applications for river bank protection were explained, bringing out the fact that vegetation growing in the silt deposits in the gabions gave an eco-friendly appearance to the structure. Technology by Maccaferri can be studied further for effective bank protection measures.

(5) Trends in Hydrographic Data Collection by Cdr. P.K. Srivastava, NHS.

The paper by Cdr. P.K. Srivastava, Chief Instructor, NHS, Goa on Trends in Hydrographic Data Collection brought out the latest techniques and instruments for bathymetric survey and positioning systems. He suggested that modern hydrographic techniques can be supplemented with latest equipment to measure current, sediment, sub bottom etc.

(6) Protection of Majuli Island against flood and erosion using RCC Porcupines and Spurs by Sh Bhagat Singh, Director (Flood Management-II), CWC.

The paper by Sh. Bhagat Singh, CWC provided a case study of protection works for Majuli Island in the Brahmaputra. The works were divided into three phases and it was suggested that the island being ecologically fragile, the third phase should not be delayed. It was pointed out the Phase –I works were completed and Phase-II and III were being combined for early implementation,

<u>Recommendations of Technical Session - II</u>

The Chairman of the Technical Session – II gave the recommendation of the session chaired by him as follows: -

1. Undertake model studies for bank protection works (of critical reaches) as recommended by the National Disaster Management Authority including dredging of rivers, keeping the needs of navigation in mind.
2. Bank protection measures should be navigation – friendly and design should be evolved avoiding rock toes.
3. Design of units such as porcupines should be codified as was done by IIT Roorkee for permeable spurs.
4. Model studies be carried out to develop eco-friendly and cost-effective measures.
5. Rapid survey techniques using modern technologies be adopted so that input data required for model studies is made available in short time for implementation of measures in the filed.

5. Final Recommendations of the Workshop on River Training Works

Keeping regard of the summary report from the two Chairmen of the two Technical Sessions after detailed deliberation the Workshop suggested the following recommendations for the future course of action by the IWAI.

(1) The experts to be identified based on the presentations made during the workshop. This group of experts would identify the various stretches on the NW-1 and NW-2 which need up-gradation/ training (disciplined) for efficient management of fairway and safe navigation of the vessels. The comprehensive data duly analyzed and plotted into usable data base are available with IWAI for identification of the various stretches.

(2) The expert group would interact and hold a comprehensive deliberation to suggest the strategies that should be economical, effective, almost permanent and foolproof (as much as possible) for the training of the various identified stretches of NW-1 and NW-2. These applicable stretches should be classified into two groups; viz the city / town stretch of the rivers and the in between towns stretches. It is suggested that the bank protection and erosion control in the stretches along the cities / towns should as far as possible be done through permanent retaining-wall type, sloping or stepping structures or through the construction of "bandals" (dam like structure parallel to the river course) on one or both sides of the river depending on the development of the town. This will not only train the city stretches of the river but also provide safe and permanent "ghats" for religious rites and / or recreation of the local population and pilgrims / tourist and provide a very aesthetic view. This will also control review pollution in a foolproof manner because the bandal /retaining wall would serve as a barrier between the town population and the river and would not let even a drop of wastewater to enter and the city stretch of the rivers. Thus the rivers would also be able to provide almost pollution free water for the drinking and industrial needs of the towns population.

(3) As recommended at (1) above, the following expert committee is recommended, under the Chairmanship of Shri S.C. Srivastava, Member (C&F), IWAI: -

(a) Outside experts:

1. Dr. Z S Tarapare, Ex. Director, CWP&RS, Pune
2. Dr. Subasisha Dutta IIT Guwahati
3. Dr. S A Sannasiraj IIT Chennai
4. Dr. Nayan Sharma IIT Roorkee
5. Dr. U C Kathiyari IIT Roorkee
6. Shri Prashant Navalakha of M/s Maccaferri, Mumbai
7. Shri M Venketraman of M/s Garware-wall Rope Ltd, Pune
8. Cdr. PK Srivastava, NHS, Goa

(b) Internal Experts

1. Capt.(IN) G.S. Inda, Hydrographic Chief
2. Shri S.S. Pandian, Chief Engineer
3. Shri M.K. Saha, Director (Guwahati)
4. Shri Arun Roy, Director (Kolkata)
5. Shri S. Dandapat, Director (Kochi)
6. Shri N.Sivaraman, Director (Patna)

(4) It is suggested that a meeting of the expert group be held in Delhi to identify the stretches of NW-1 & NW-2 for river training works and then the methodology to be adopted for each such stretches be evaluated keeping regard to Indian river conditions, economy, feasibility, efficiency etc.

(5) Lastly, tenders from specialist firms be invited for the execution of the river training works to be compared in a twin-framed schedule.

(6) The NINI has an extra ordinary infrastructure facility but unfortunately, it is most under utilized and suggest that a Hydrographic course (B.Tech / Master level) may be started at this institute. These courses can be accredited to the Institution of Surveyors (India) at New Delhi for degree and academic standards.

(7) The matter of Award of certificate to Deck and Engine side to the trainees being trained at NINI may be explored under the IWAI Act. This has been suggested by Capt. Mascranhas, Capt.of Ports Goa.

(8) It is also suggested that Private Shipping companies operating in National Waterways and IWAI to sponsor candidates for training in Deck / Engine side similar to being done by Maritime Institute for better job opportunities.

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Recommendations on River Training Works for Field Directors & Resource Persons

Based on the Recommendations of Workshop on River Training Work in NWs the following recommendations are prepared for Field Directors & Resource Persons: -

(1) A technical advisory committee (TAC) will be formed to identify the various stretches on NW-1 & NW-2 which need up-gradation / training for efficient management of fairway and safe navigation of the vessels. This committee will consist of the following in-house and external members: -

(i)	Shri S.C. Srivastava, Member (C&F), IWAI	-	Chairman
(ii)	Capt. (IN) G.S. Inda, Hydrographic Chief, IWAI Secy.	-	Member
(iii)	Shri S.S. Pandian, Chief Engineer, IWAI	-	Member
(iv)	Shri M.K. Saha, Director, IWAI, Guwahati	-	Member
(v)	Shri Arun Roy, Director, IWAI, Kolkata	-	Member
(vi)	Shri S. Dandapat, Director, IWAI, Kochi	-	Member
(vii)	Shri N.Sivaraman, Director, IWAI, Patna	-	Member
(viii)	Dr. Z S Tarapare, Ex. Director, CWP&RS, Pune	-	Member
(ix)	Dr. Subasisha Dutta, IIT, Guwahati	-	Member
(x)	Dr. S A Sannasiraj, IIT, Chennai	-	Member
(xi)	Dr. Nayan Sharma, IIT, Roorkee	-	Member
(xii)	Dr. U C Kathiyari, IIT, Roorkee	-	Member
(xiii)	Cdr. PK Srivastava, NHS, Goa	-	Member
(xiv)	Shri Prashant Navalakha of M/s Maccaferri, Mumbai	-	Member
(xv)	Shri M Venketraman of M/s Garware-wall Rope Ltd, Pune	-	Member

(2) Under this Technical Advisory Committee (TAC), four sub-committees will be formed to conduct studies and collect the data on zonal level basis: -

For NW-1 – (A) Allahabad to Rajmahal (Allahabad – Chunar – Gazipur – Patna – Bhagalpur – Rajmahal)

(i)	Shri N. Sivaraman, Director, IWAI, Patna	-	Chairman
(ii)	Dr. U.C. Kathiyari, IIT, Roorkee	-	Member
(iii)	Sh. Prashant Navalakha of M/s Maccaferri, Mumbai	-	Member

(B) Rajmahal to Tribeni (Rajmahal – Farakka – Tribeni)

(i)	Shri Arun Roy, Director, IWAI, Kolkata	-	Chairman
(ii)	Dr. Nayan Sharma, IIT, Roorkee	-	Member
(iii)	Sh. Prashant Navalakha of M/s Maccaferri, Mumbai	-	Member

For NW-2 – (C) Bangladesh Border to Neamati (Bangladesh Border – Pandu – Neamati)

(i)	Shri M.K. Saha, Director, IWAI, Guwahati	-	Chairman
(ii)	Dr. S.A. Sannasiraj, IIT, Chennai	-	Member
(iii)	Shri M Venketraman of M/s Garware, Pune	-	Member

(D) Neamati to Sadiya (Neamati – Dibrugarh – Sadiya)

(i)	Shri M.K. Saha, Director, IWAI, Guwahati	-	Chairman
(ii)	Dr. Subasisha Dutta, IIT, Guwahati	-	Member
(iii)	Shri M Venketraman of M/s Garware, Pune	-	Member

(3) The comprehensive data collected will be duly analyzed and plotted into usable data base at Hydrographic Wing of concerned field offices for identification of the crucial stretches in NWs.

(4) It is suggested that a meeting of the technical advisory committee be held in Delhi every after 3 months to identify the crucial stretches of NW-1 & NW-2 for river training works and then the methodology to be adopted for each such stretches be evaluated keeping regard to Indian river conditions, economy, feasibility, efficiency etc.

(5) The technical advisory committee would interact and hold a comprehensive deliberation to suggest the strategies that should be economical, effective, almost permanent and foolproof (as much as possible) for the training of the various identified stretches of NW-1 and NW-2.

(6) It is suggested that the bank protection and erosion control in the stretches along the cities / towns should as far as possible be done through permanent retaining-wall type, sloping or stepping structures or through the construction of "bandals" (dam like structure parallel to the river course) on one or both sides of the river depending on the development of the town. This will not only train the city stretches of the river but also provide safe and permanent "ghats" for religious rites and / or recreation of the local population and pilgrims / tourist and provide a very aesthetic view. This will also control review pollution in a foolproof manner because the bandal /retaining wall would serve as a barrier between the town population and the river and would not let even a drop of wastewater to enter and the city stretch of the rivers.

(7) Lastly, tenders from specialist firms be invited for the execution of the river training works to be compared in a twin-framed schedule.

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VOTE OF THANKS BY DIRECTOR, IWAI, PATNA

Respected participants of the workshop on "River Training Works", we have reached to the end of the session, where we have to take leave from the workshop session, of course with a sense of enjoyment and with a deep understanding of carrying a share of the knowledge, which definitely will be helpful for implementation and helpful for future technical analysis with improvement and implementation.

The session completed is nothing but a congregated effort of various stake holders to whom I like to place my gratitude, without which the session can not be concluded.

At the outset, I like to place my gratitude for the opportunity lead to consider this workshop in such an ancient place seen the various phases of different dynasty and also observed the sacred river "GANGA" closely and this is nothing but a major boon for such river bound activities and the opportunity for conducting the workshop at PATNA itself is a gifted one for which I like to extend my gratitude.

On behalf of IWAI and as Director, IWAI, Patna I like to extend my sincere gratitude for the encouragement extended by our Hon'ble Chairman, IWAI, without which the session would not have been initiated at all. Further, the blessings provided by Chairman through the MESSAGE is a great strength for the session, for which I like to place my gratitude.

I like to extend my thanks to Sh. S.C. Srivastava, Member (Cargo & Finance), IWAI & Chairman, PAC, NINI for the continued support provided for the development of NINI and for conducting the subject workshop and also for participating the workshop as a Chief Guest, in spite of his busy schedule.

I like to extend my thanks to Capt.(IN) G.S. Inda, Hy. Chief who took lot of interest and initiative and instrumental to make the workshop a success.

I like to convey my sincere thanks to welcome Chief Resource Person Prof (Dr.) D. S. Bhargava Ex. REC (Now IIT, Roorkee) and fellow Emeritus Institution of surveyors, who has spared his valuable time to be the Chief Resource Person and conduct this workshop.

I am thankful to Sh. G. Prasanth, IWAI Survey official, who has presented the overview of the Departmental / Survey activities.

I would like to extend my sincere thanks to the experts in the subject field from various prestigious organizations viz., IIT, Chennai; IIT, Guwahati; IIT, Roorkee; CWPRS; CWC; Brahmaputra Board, National Hy. School etc., and attended the Workshop as Distinguished Resource Persons i.e.

Dr. Subhashisa Dutta, IIT Guwahati,
Sh. Z. S. Tarapore, Ex. Director, CWPRS and Advisor WAPCOS,
Sh. G. P. Singh, Secretary, Brahmaputra Board.
Sh. M. Venkataraman, Garware-wall Ropes Ltd.
Sh. Pankaj Kumar, IIT Roorkee,
Sh S. K. Agarwal, Ex. Member, CWC and Consultant of NMDA,

Prof. U. C. Kothiyari, IIT Roorkee,
Dr. Sannasiraj, IIT Chennai,
Cdr. P. K. Srivastava, CI, NHS, Goa,
Sh. Bhagat Singh, Director (FM II), CWC
Sh. Prasanth J. Navalakar, Meccaferri Ltd.

I like to convey my special thanks to Sh S. K. Agarwal and Sh. Z. S. Tarapore for shouldering the responsibility of chairing the sessions.

My sincere thanks to the participated PAC members; CPWD officials; Rail Bridge Project officials.

Last but not the least the participants from our IWAI from various other offices including the HQ office viz., S. S. Pandian, Chief Engineer; Directors from Kochi [Sh. S. Dandapat]; Kolkata [Sh. Arun Roy]; and Guwahati [Sh. M. K. Saha]; (who also took the responsibility of session Reuters); Dy. Director [Sh. Ravikant] and also the participants from the sub offices from Farakka; Bhagalpur; Varanasi and Allahabad.

Further, I like to place my sincere gratitude to Sh. R. C. P. Sinha, Principal, NINI who has extended full support along with his Faculty and trainees of NINI to make the workshop a success.

PRESS and MEDIA always will have a special role in every spectrum in the activities, who place the views / ideologies including its propagation and I like to convey my special thanks for attending the workshop and to project the ideology of the workshop to the public / concerned.

As a host and as a Director, IWAI, Patna, I like to place my view that the success of the workshop is the joint and congregated effort of the entire officers / staff of IWAI, Patna, to whom I am personally indebted.

In such a workshop, there may be a possibility of miss in extending the gratitude, which may be considered with a positive note.

With the above I on behalf of IWAI and the entire organizing committee of this workshop place my gratitude to one and all for making this workshop a success.

(N. SIVARAMAN)
Director, IWAI, Patna

PHOTOGRAPHS OF THE WORKSHOP

Photographs of the Workshop


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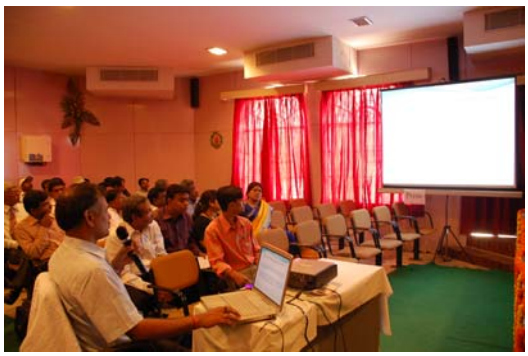

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