

GUIDELINES ON TRAINING OF HIGHWAY PROFESSIONALS



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GUIDELINES ON TRAINING OF HIGHWAY PROFESSIONALS

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CONTENTS

Description	Page No.
Personnel of the General Specifications and Standards Committee	i-ii
Introduction	1
Chapter 1: Necessity for Training	4
Chapter 2: Career Development	5
Chapter 3 : Scope of Training	7
Chapter 4: Training at Entry Level	11
Chapter 5: Training at Middle Level	13
Chapter 6: Training at Senior Level	16
Chapter 7: Training at Top Level	19
Chapter 8: Organizing Training	22
Appendix: Training Areas for Professionals	24

ABBREVIATIONS

ADB	Asian Development Bank
AICTE	All India Council for Technical Education
BOT	Build-Operate-Transfer
BOOT	Build-Own-Operate-Transfer
BRICS	Brazil, Russia, India, China and South Africa
BRO	Border Roads Organization
CBR	California Bearing Ratio
CPWD	Central Public Works Department
CMV Act	Central Motor Vehicle Act
CRF	Central Road Fund
CRF Act	Central Road Fund Act
CRRRI	Central Road Research Institute
DPR	Detailed Project Report
DR	District Road
EIA	Environmental Impact Assessment
EPC	Engineering, Procurement and Construction
ETC	Electronic Toll Collection
FIDIC	International Federation of Consulting Engineers
FIRR	Financial Internal Rate of Return
GIS	Geographical Information System
GPS	Global Positioning System
IAHE	Indian Academy of Highway Engineers
IIT	Indian Institute of Technology
IIM	Indian Institute of Management
IRDB	International Bank for Reconstruction and Development
ITS	Intelligent Transport System
JICA	Japan International Cooperation Agency
KMS	Knowledge Management System
LA Act	Land Acquisition Act
MDR	Major District Road

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MoRTH	Ministry of Road Transport & Highways
MV Act	Motor Vehicle Act
NHAI	National Highways Authority of India
NH	National Highway
NHIDCL	National Highways & Infrastructure Development Corporation Limited
NIT	National Institute of Technology
NRMB	Natural Rubber Modified Bitumen
ODR	Other District Road
PMB	Polymer Modified Bitumen
PMGSY	Pradhan Mantri Gram Sadak Yojana
PPP	Public Private Partnership
PWD	Public Works Department
QC	Quality Control
RFP	Request for Proposal
RFQ	Request for Quotation
ROW	Right of Way
RR	Rural Roads
SH	State Highway
WB	World Bank

**PERSONNEL OF THE GENERAL SPECIFICATIONS
AND STANDARDS COMMITTEE (GSS)**

(As on 25th April, 2018)

- | | | |
|-----|---------------------------------------|--|
| 1. | Kumar, Manoj
(Convenor) | Director General(RD) & Special Secretary to the Govt. of India, Ministry of Road Transport & Highways, New Delhi |
| 2. | Nagpal, A.K.
(Co-Convenor) | Additional Director General, Ministry of Road Transport & Highways, New Delhi |
| 3. | Balakrishna, Y.
(Member Secretary) | Chief Engineer(P&B)SR&T, Ministry of Road Transport & Highways, New Delhi |
| 4. | Agrawal, C.P. | Secretary, Public Works Department, M.P. |
| 5. | Amitabh, Manu | Chief Engineer, Central Public Works Department, New Delhi |
| 6. | Basu, Kaushik | Chief Engineer, Ministry of Road Transport & Highways |
| 7. | Bhandari, Dr. R.K. | Chairman, INAE & Geohazard Specialist, New Delhi |
| 8. | Chandra, Dr. Satish | Director, Central Road Research Institute, New Delhi |
| 9. | Garg, Anil Kumar | Chief Engineer(NH), PWD, Rajasthan |
| 10. | Jha, Kumar Neeraj | Associate Professor, Indian Institute of Technology, Delhi |
| 11. | Kumar, Ashok | Consultant, M/s Feedback Infrastructure, New Delhi |
| 12. | Kumar, Dinesh | E-in-C(Retd.), Public Works Department, Delhi |
| 13. | Kumar, Uttam | Director(Projects), National Rural Roads Development Agency, New Delhi |
| 14. | Lal, Mohan | Superintending Engineer-North, Delhi PWD, New Delhi |
| 15. | Mathur, Harish | Technical Director, IL&FS, New Delhi |
| 16. | Mehta, U.C. | Addl. DGBR(East), Border Roads Organization |
| 17. | Nahar, S.S. | Director, Indian Academy of Highway Engineers, Noida |
| 18. | Patankar, V.L. | Addl. Director General(Retd.), Ministry of Road Transport & Highways, New Delhi |
| 19. | Pawar, Ajit | Secretary(Retd.), Maharashtra PWD |
| 20. | Pipri, K.K. | Chief Engineer, National Highways, Raipur |
| 21. | Prakash, Indu | DG(RD) & SS(Retd.), Ministry of Road Transport & Highways, New Delhi |

22. Puri, S.K. DG(RD) & SS(Retd.), Ministry of Road Transport & Highways, New Delhi
23. Rajawat, V.K. Technical Director, NHIDCL, New Delhi
24. Rajoria, K.B. Engineer-in-Chief(Retd.), Delhi PWD, New Delhi
25. Rao, P. Ravinder Engineer-in-Chief(R&B), Hyderabad
26. Sharma, R.S. Managing Director, M/s STP Limited, New Delhi
27. Singh, A.K. Member(Projects), National Highways Authority of India, New Delhi
28. Singh, B.N. Additional Director General, Ministry of Road Transport & Highways, New Delhi
29. Singh, Nirmaljit DG(RD) & SS(Retd.), Ministry of Road Transport and Highways, New Delhi
30. Singh, V.K. Engineer-in-Chief, PWD, U.P.
31. Sinha, A.V. DG(RD) & SS(Retd.), Ministry of Road Transport & Highways, New Delhi
32. Subbhiya, Ravindra CDE, Larsen and Toubro, Chennai
33. Verma, Maj V.C. President, National Highways Builders Federation, New Delhi
34. Wakchaure, Dr. Sanjay Superintending Engineer, Ministry of Road Transport & Highways, New Delhi

Corresponding Members

1. Indoria, R.P. DG(RD) & SS(Retd.), Ministry of Road Transport & Highways
2. Swarup, Dr. P.R. Director General, Construction Industry Development Council, New Delhi

Ex-Officio Members

1. President, IRC (Reddy, K.S. Krishna), Managing Director, M/s KRDC Ltd.
2. Director General (RD) & Spl. Secretary to the Govt. of India (Kumar, Manoj), Ministry of Road Transport and Highways, New Delhi
3. Secretary General (Nirmal, S.K.), Indian Roads Congress, New Delhi

GUIDELINES ON TRAINING OF HIGHWAY PROFESSIONALS

INTRODUCTION

Developed infrastructure provides strong backbone for sustainable socio-economic development of a Nation and Highways being the most important infrastructure, form the arteries of economic development. Therefore, construction of good highway infrastructure along with sustainable environment is the need of the hour for economic development of the country. India is one of the fast developing economies of the World. It has a large network of roads and includes 1,32,500 km of National Highways, 1,56,694 km of State Highways and vast network of Rural and Other Roads aggregating to about 56,08,477 km. The development and requirement of roads was well emphasized by the Planning Commission of India under the 12th Five Year Plan. An amount of Rs. 9,14,536 crore was projected for the Road Sector. Annually an amount of over Rs. 1,25,000 crore is spent in development of National Highways only.

For meeting the requirements of the development of road infrastructure, there is huge necessity of qualified technical manpower having expertise in various fields of Highways and Bridges viz. Planning, Design, Construction and Maintenance etc. Taking into consideration the available facilities for development of skill and expertise, there exists a gap between the requirement and availability of training institutes as well as faculties in the road sector. In fact, a number of training courses being run by different institutes, are much less than the requirements. Engineering professionals need to gain knowledge in many areas which may not be part of their engineering studies, especially Law, Financial Norms, International Funding, Policy Planning for PPP Projects and Model Contract Conditions as per International practice etc.

In view of the above, this document has been prepared by the Human Resources Development Committee (G-2) concerned with Human Resource Development in the road sector. It is hoped that this document will be useful for developing course material and curriculum for various training courses and may help in bridging the gap in the training needs of road sector engineers as well as professionals. With trained professionals, there is bound to be qualitative and quantitative improvement in the delivery of road projects.

The document is a follow-up of the main document on IRC:SP:92-2010 “Road Map for Human Resource Development in Highway Sector”.

Other human resources working for highway sector includes workmen, operators etc. for which another document entitled IRC:127-2018 “Guidelines on Skill Development of Workmen in Road Sector” may be referred to.

The G-2 Committee (personnel given below) in its 6th meeting held on 14th June, 2016 approved this document for submission to the GSS Committee. The GSS Committee in its meeting held on 24th June, 2017 after deliberations, referred the document to Sub-Group of GSS constituted comprising CE, S,R&T(R), MoRTH, Director, IAHE, Shri K.B. Rajoria, Convenor, G-2 Committee & Shri B.N. Singh, Co-Convenor, GSS Committee to look into matter and reframe the document covering all aspects as discussed in the meeting while keeping harmony with MoRTH policy on training. The document was discussed in a number of meetings by Sub-Group and the Sub-Group in its meeting held on 19.01.2018 finalized the draft document for

onward submission to GSS Committee. The document was approved by the GSS Committee in its meeting held on 25.04.2018 for placing before the Council for its consideration. The Council in its 215th meeting held on 4th May, 2018 at Aizawl (Mizoram) after deliberations authorized the Executive Committee to take final call about Publishing of the document. The Executive in its meeting held on 4th August, 2018 approved the document for publishing.

The list of personnel of G-2 Committee is as under:

Rajoria, K.B.	Convenor
Jhamb, S.B.	Co-Convenor
Bansal, Shishir	Member Secretary

Members

Amla, T.K.	Pokhriyal, Col. Anil Kumar
Bala, Ms. Shashi	Porwal, Dr. S.S.
Basar, Toli	Saxena, Col. Nishith Behari
Bhatia, Ms. Upma	Sharan, G.
Bikshapathi, Kondai	Sharma, K.C.
Deshwal, Dinesh C.	Shrivastava, O.P.
Goel, O.P.	Srivastava, H. K.
Gupta, Ms. Aparajita Das	Verma Maj. V.C.
Gupta, D.P.	Verma, Ms. Anjali
Kumar, Uttam	Vij, S.K .
Mahalaha, R.S.	Vyas, D.B.
Pandey, I.K.	

Corresponding Members

Agarwal, Prof. (Dr.) P.K.	Pariyar, R.K.
Agrawal, K. N.	Subramaniun, Prof. K.
Gangadharam, M.	

Ex-Officio Members

President, IRC (Reddy, K.S. Krishna)	DG(RD) & SS, MoRTH (Kumar, Manoj)
Secretary General, IRC (Nirmal, S.K.)	

It may not be out of place to acknowledge the contribution of members of the earlier Committee. Shri D.P. Gupta, DG(RD) & AS (Retd.), MoRTH initiated the concept. The same has been

elaborated and finalized by the Committee. Contribution of some members is also worth mentioning which include Shri O.P. Goel, DG (Retd), CPWD, Shri V.S. Khaira, SE, MoRTH, Shri V.K. Sharma, CE, CPWD and Shri S.P. Banwait, ADG (Retd.), CPWD. During 5th meeting of G-2 Committee held on 16.05.2016, some additional suggestions were given by Shri D.P. Gupta about tunneling, Shri Kondai Bikshapathi, DG, National Academy of Construction Hyderabad, suggested to add about Knowledge Management System and Shri D.B. Vyas, Joint Director, STC, Gandhinagar suggested to mention about Highway Aesthetics/ Landscaping Architecture in the document. These suggestions have also been incorporated in the document.

The Officers of the S&R Zone of the Ministry of Road Transport & Highways especially Dr. Sanjay Wakchaure, SE have scrupulously revised the document by adding supplementary text, reorganization, editing and proof reading which has resulted the document in the present form.

In **Chapter 1** the necessity of professional development has been described. The seminal document of G-2 Committee, road map for delineated training needs and implementation framework are also given in **Chapter 1**. Training is different from basic engineering. The training institutes must appreciate and differentiate the two. It is to be appreciated that a fresh graduate or diploma in civil engineering or highway engineering, needs inputs in different fields related to roads & bridges from inception to operation and maintenance.

Chapter 2 deals with Career Development in the road sector. In **Chapter 3**, the broad scope of training areas is given. It covers engineering, codes and schedules, knowledge of skills, laws of land, foreign funding, project development etc. **Chapter 4** gives broad outline of Induction or Entry Level Training. **Chapter 5** describes training requirements at Junior and Middle Level Engineers. The Government Engineers of the level of or professionals Assistant Engineer, Assistant Executive Engineer, Executive Engineer and also their equivalents namely Deputy managers, Managers, Deputy General Managers in Public Undertakings, Contractors and Consultants are covered in this group. **Chapter 6** gives training needs of Senior Middle Level Engineers i.e. Superintending Engineers/Additional Chief Engineers and Chief Engineers which are equivalent to General Manages/Chief General Managers of Public Undertaking, Contractors and Consultants. **Chapter 7** gives training requirements of top level engineers, professionals and administrators etc. The Heads of Departments of Engineering/Public Organizations, Policy Professionals and Administrators in the Government and Heads of Private Sector Organizations are covered in this group. As a policy, all professionals working in the highway sector must get trained in their field of working at all levels including at entry level. **Chapter 8** gives brief details on organizing the training.

CHAPTER 1

NECESSITY FOR TRAINING

1.1 The IRC has developed Standards, Specifications, Guidelines and Codes of Practice in almost all conceivable areas relating to Highways & Bridges. It is seen that there is a visible gap between the laid down Standards and Practice followed for actual execution. There is a gap between 'what should have been' and 'what has been done'. The IRC:SP:92-2010 "Road Map for Human Resource Development in Highway Sector" has delineated training needs and how the same is to be imparted within the overall ambit of organizational development. "The Road Development Plan and Vision 2021" document of Government of India has laid emphasis on the capacity building of various stakeholder organizations which include strengthening of decision support system by way of development of strong data base, specialization of professionals, re-engineering of Organizations for sound decision making, synchronization of working in the organizational set up and development of skilled man power. These objectives require that Highway Professionals are trained in such a way that their skills and knowledge synchronizes with the necessity of country at present as well as in future for developing world class highway network. As a follow up of the above objectives, these "Guidelines on Training of Highway Professionals" have been made. The identified training areas where Highway Professionals are required to be given exhaustive exposure so that they can perform their tasks as expected and in conformity with the laid down Standards and Specifications are enumerated. These training areas are supposed to acquaint Highways Professionals to the varied complexities and intricacies needed that are to be taken into consideration either while making a decision or while executing construction works of roads, bridges etc.

1.2 The objective of identifying training areas is to create conditions so that all those who are involved in road infrastructure in the country should understand as to what they are doing and what they are expected to do. These training modules would help in minimizing the gap between what one knows and what one is expected to know.

1.3 Training modules will however have to be suitably modelled depending upon the nature of the target group for Officers at three levels, i.e., (i) Junior/Entry Level, (ii) Middle Level, and (iii) Senior/Top Level.

1.4 It is hoped that the training areas prescribed will be immensely useful to all those working in the Ministries and Road Development Organizations both in the Central and State Governments as well as Private Construction Agencies, Laboratories, Consultants, Concessionaire, Environmentalists and even Public Representatives engaged in some way or the other with highway planning, development, construction and maintenance.

1.5 Approach of training in the sphere of roads & bridges including R&D shall be multi-disciplinary to know how to minimize resources, increase output & efficiency in an optimal manner. One must know the role and responsibilities to attain the highest achievement in not only quantity but quality with integrity. Professionals are to be encouraged & incentivized to take field as well as R&D activities.

CHAPTER 2

CAREER DEVELOPMENT

2.1 Professionals joining highway sector in Government Organizations or Private Agencies after graduation or diploma in Engineering are assigned specific tasks. They have background of engineering studies but that is not considered adequate for performing the assigned task in an expected manner. To some extent, guidance can be given by seniors in the Organization, but it is not adequate to perform effectively. Therefore, it is essential that practical knowledge is imparted by trainers, who have the background of practice of engineering in specific areas of highways & bridges. Professionals have to acquire the requisite skills by getting trained at different periods of their career development.

2.2 Training of engineering professionals at different levels, as a part of career growth is necessary and essential not only for the individual but for the Organization as well. It may be made mandatory for all the Organizations to impart the induction training of around 6 months at their own training facilities or central institutes like IAHE/CRRRI.

This training is to be imparted in such a manner that every individual gets personal attention of the trainer. Therefore, number of trainees in a class should be limited and preferably in the range of 20-25. The trainer must have background of professional work. For learning and attending required level of proficiency, trainer and trainee have to intercommunicate during training. For their guidance, different steps to be followed have been detailed below:

- i) Tell the trainee what to do.
- ii) Show the trainee what to do.
- iii) Make him tell what he has to do.
- iv) Tell the trainee how to do.
- v) Show the trainee how to do.
- vi) Show the trainee why to do.
- vii) The trainee should tell what he has to do.
- viii) The trainee should tell how he will do.
- ix) The trainee should tell why he has to do.
- x) Let trainee do the job by working on practical exercise.
- xi) Let trainee improve the job with the intervention and interaction with the trainer.
- xii) Let the trainee practice to the extent that skills are acquired, and.
- xiii) Let the trainer check and acknowledge that trainees have acquired the knowledge and skills.

2.3 The broad horizons for training have to extend much beyond acquiring skills and knowledge. The skills acquired are to be utilized in doing the assigned task and its management. Modern management concepts propagate individuals' involvement beyond mind. It has to extend to heart and soul. Imparting training by covering all the aspects will raise sphere of knowledge and training will be useful not merely for performance of task but making individuals as better human beings.

2.4 Training is not meant for development of robot of whom no further development is possible. Prime objective is to enhance the skill to implement the theory into practice and not that what a particular individual / group is intended to do in an organization. Training is meant not only for development of expertise but also for character development.

2.5 It may not be out of place to mention that highway engineers have to develop the habit of acquiring knowledge throughout their career and beyond. Therefore, one has to keep in touch with the professional knowledge by reading and referring to the latest books and journals on the subject. Besides, in order to enlarge prospect of knowledge and skills, frequent field visits are also necessary. Simultaneously, acquired knowledge and skills need to be shared. For this purpose, Highway Engineers should attend Conferences, Seminars, Workshops etc. both as delegates and presenters. With the passage of time, the trainee may have to develop himself as a trainer. It must be understood that keeping knowledge to self only deprives others. The practical knowledge if propagated and shared will benefit the public in general and highway sector in particular. Therefore, Engineers should feel encouraged to write papers, articles and books.

2.6 All the Professionals should be encouraged and incentivized to acquire higher qualifications.

CHAPTER 3

SCOPE OF TRAINING

3.1 Knowledge horizons of Highway Engineers have to be continuously and consistently expanded & upgraded as they move up the ladder in their career. While no boundary conditions for acquiring the knowledge can be defined, efforts have been made to identify areas where the highway engineers need to acquaint themselves during different stages of their career in various facets of highway & bridges. Imparting of practical technical knowledge to professionals has to be done as a part of human resource development within the framework of requirements of the Organization. Thus, human resource development and management exercise has to be initiated by the employer organizations for training of professionals.

3.2 Engineering: It is considered necessary to impart practical training in various fields of engineering. These may include but not limited to:

- i) Highway Engineering
- ii) Bridge Engineering
- iii) Traffic & Transportation Engineering
- iv) Environmental & Safety Engineering
- v) Instrumentation
- vi) Surveying
- vii) Materials & Techniques for Construction
- viii) Information Technology and Knowledge Management
- ix) Geotechnical Engineering
- x) Asset Management
- xi) Value Engineering
- xii) Analysis & Design Techniques

In order to avoid a monotony of training, inter-disciplinary approach shall be followed keeping in mind the sustainability, adopting observational methods and promoting multiple alternatives to the same cause.

3.3 Codes & Guidelines: Different Organizations carry out their assigned task by following Rules, Codes of Practice and Schedules etc. Broadly these may include but not limited to:

- i) Finance Rules and Strategic Documents/Reports
- ii) IS Codes
- iii) IRC Codes/Documents
- iv) Departmental Circulars, Codes and Manuals
- v) Schedule and Analysis of Rates
- vi) Standard Specifications
- vii) Contract Documents/Forms
- viii) International Codes & Practices

3.4 Skills: Skill development is a recurring need and not a onetime affair. New technologies could be a game changer in skill development. Engineering Professionals are about 5 % of total manpower directly working in Highway Sector. Balance 95% include supporting staff in offices, Skilled and Unskilled Workers, Surveyors, Safety Officials, Field Laboratory Staff, Computer Operators, Store keepers, Supervisors, Machine Operators, Scaffolders etc. It is necessary that Highway Professionals also acquire basic knowledge about job requirements of work force. Various skills to be acquired may include but not limited to:

- i) Material Testing
- ii) Basics of Equipments and Machineries
- iii) Information Technology
- iv) Management Skills
- v) Communication Skills
- vi) Human Behavior, Stress & Self Management
- vii) Noting, Drafting & Report Writing Skills

Skills shall create potential for new jobs and enhance income. Mapping of capacities and accreditation of training institutions and agencies may be done in order to assess the quality of Trainers and Training Materials.

3.5 Constitution of Bylaws: Requisite knowledge is necessary about constitution and laws particularly in the context of obligations to be fulfilled by National & International Laws. Besides, knowledge of Contract Act/ Arbitration Act and Limitation Act is particularly required for dealing with Contracts and Arbitrations. Moreover, several Acts and related rules and regulations are concerning highway profession, such as National Highways Act, CRF Act, LA Act, CMV Act, Control of Land and Traffic Act etc. Besides, there are Acts related to State Highways, Rural Roads etc. It is necessary that Highway Professionals are familiar with the provisions of these Acts.

3.6 Foreign Funding Professionals and National/ State Level Programmes: It is necessary to have knowledge about various international funding agencies like IRDB, ADB, JICA, BRICS, EU etc. their policies, programmes and procedures. The procedure for operation of the funds as budgeted in the Government is also necessary.

3.7 Project Development & Implementation: A project has to pass through different stages and the Highway Professionals ought to know implementation & operation of these stages. The broad list of these stages is as below:

- i) Preliminary Proposal, Budgeting and Approval
- ii) Preconstruction Activities
- iii) Detailed Location Survey and Investigation
- iv) Geometric Analysis & Design
- v) Cost Estimation
- vi) Specifications for the Project
- vii) Design and Detailed Drawings
- viii) Tender (Bid) Document and Notice inviting Tenders
- ix) Evaluation of Bids and Award of Work

- x) Execution of Works
- xi) Quality Control and Quality Management Systems
- xii) Contract Management & Arbitration,
- xiii) Operation & Maintenance Management

3.8 Specialized Fields: Knowledge base for different fields of highway engineering is widening at a fast pace. It is necessary that highway professionals acquire specialized knowledge as required. Specialized fields include:

- i) Analysis & Design of Structures
- ii) Reinforced Earth Walls
- iii) Material Management
- iv) Flexible Pavements
- v) Rigid Pavements
- vi) Urban Roads
- vii) Drainage of Road System
- viii) Drainage of Urban Roads
- ix) Safety – Planning & Implementation
- x) Pavement and Structure Inventory, Inspection & Performance Evaluations
- xi) Soil Stabilization
- xii) Asset Management
- xiii) Corridor Management
- xiv) Disaster Management
- xv) Environment Impact
- xvi) Quality Control and Audits
- xvii) Safety Assessment & Audits
- xviii) Highway Aesthetics
- xix) New Materials & Technologies for Surveying Analysis Design, Construction, Maintenance & Operation
- xx) Tunneling, and
- xxi) Use of IT and Space Technology, GIS, GPS in Highway Sector

3.9 In order to have guidance to Training Agencies for training in various fields, training modules have been prepared for the listed training areas and are given in **Appendix**. These training modules will vary in their contents and detailing depending upon level of Professionals i.e. whether Junior or Middle or Senior Level. Some of the training areas meant for Junior and Middle Level Professionals may not be necessary for Senior Level Professionals except for the general overview while covering other aspects which are relevant for higher level. Similarly training modules shall be ‘General’ ‘Specialized’ and ‘Super-specialized’ in their content depending upon the target group and their assignments in their organizations. The training program shall vary from ‘Short Term’, ‘Medium Term’ to ‘Long Term’ depending upon specific requirements of the target group and human resource development policy of the Road Agencies or the Private Sector.

3.10 There may be necessity of creating a resource centre/hub comprising of Professionals, Subject Experts, Administrators who have acquired a wealth of knowledge, skills and domain expertise on one or other aspect of highway sector. They may be retired or working professionals having knowledge about specialized subject with upto date information about Specifications, Government Circulars and Orders etc. Some of them may be Specialists on matters concerning agencies like ADB, IRDB, JICA etc. Some can be experts on the latest software and instrumentation techniques being employed in highway sector. Such pool of experts will have to be harnessed for disseminating practical knowledge and skills based on vast experience in their related fields. Thus an inventory of National and International experts will be required, for imparting training. All the training agencies shall prepare and maintain online details of experts. All the training institutes must have the requisite number of trained trainers in various fields of highway and bridges.

3.11 The web based Knowledge Management System (KMS) for Highway Engineers may be developed. The IT tools where members can access repository of documents, Rules, Codes, Guidelines etc. There is a web based Discussion Forum Functionality in the KMS which can be used for effective interaction with the subject matter experts. The training shall be imparted in house, field as well as on line.

3.12 Knowledge of all aspects of Roads & Bridges is required at all levels. Hierarchy of Professionals should be reflected in training module. It is the degree & Intensity of knowledge requirements that differ and shall be the basis for development of training modules.

Depending on the level of the Professionals, extent of the depth of the training may be decided on the basis of the following but not limited to:

- i) Level of Training
- ii) Job Profile
- iii) Role & Responsibilities
- iv) Policy Trends
- v) Emerging Challenges
- vi) Expertise Requirement
- vii) New Emerging Material & Techniques
- viii) Execution/Management/Monitoring
- ix) Policy Making
- x) Feedback

3.13 In order to assess the effectiveness of trainings an appropriate evaluation/Feedback Proforma shall be prepared.

CHAPTER 4

TRAINING AT ENTRY LEVEL

4.1 Diploma holders, Graduates and Post Graduates in Civil, Electrical & Mechanical Engineering are generally employed in Highway Sector. These fresh graduates are by and large not suitable straightaway for the professional work. Some employers have facilities for in-house training, after the employment is offered. Those employers who do not have such facilities remain at a disadvantage. By and large, these fresh graduates are not adequately competent to take the challenges of the professional work being assigned to them. It is, therefore, desirable to ascertain areas of knowledge and field work in which training is to be given to new entrants to make them professionally suitable.

4.2 In Engineering Institutes, students learn different engineering subjects and lack knowledge of field practices. The teachers of engineering can be and should be professionals who have gained experience from management of projects. They can impart training on the basis of their experience. Some important fields which should be covered for induction/entry level training of engineering professionals include but not limited to:

- i) Specifications and Schedule of Rates
- ii) Procedures for Planning, Designing and Execution of Engineering Projects
- iii) Preparation of Estimates and Detailed Project Reports
- iv) Relevant IS Codes, IRC Documents, CBIP (Central Bureau of Irrigation and Power) Documentation
- v) Departmental Procedures & Conduct rules
- vi) Commonly used software in Design and other Civil Engineering Activities
- vii) Quality Control and Quality Management
- viii) Technical Audits
- ix) Safety Engineering Principles
- x) Contract Management and Indian Contract Act
- xi) Arbitration & Conciliation Act
- xii) Management Development Program
- xiii) Value Engineering
- xiv) Green and Sustainable Roads
- xv) Ethics
- xvi) General Finance Rules
- xvii) Asset Management
- xviii) Field visits
- xix) Orientation Program
- xx) Field Specifications
- xxi) New Materials & Techniques, Laboratory and Field Testing
- xxii) Construction & Maintenance Techniques
- xxiii) Communication Skills

- xxiv) Geotechnical Investigation
- xxv) Disaster and Multiple Hazard Management
- xxvi) Noting, Drafting & Report Writing Skills

4.3 Besides the input of knowledge as indicated in **Para 4.2**, it is also desirable that Engineers acquire skills of Artisans, Supervisors and Operators, who work for construction sector as detailed below:

- i) Role and function of Site-supervisor, Laboratory Assistant, Storekeeper, Surveyor, Mechanic and Foremen who are the link between Engineering Professionals and Workmen. Engineers should have acquaintance on work experience on these positions.
- ii) Several trades are covered in construction sector but there are five basic trades in which Engineers should know intricacies of the job. These trades are performed by, (a) Mason, (b) Scaffolding Carpenter, (c) Bar Bender, (d) Fitter (e) Electrician (f) Welder etc. Every Engineer should be familiar with all the tools used for these trades.
- iii) Equipments are extensively used for construction. Engineers have to become familiar with working of Cranes, Excavators, Road Rollers, Graders, Pavers etc. Besides, they should learn about working of Hot Mix Plant, Concrete Batching Plant, WMM Plants, Crusher etc.

4.4 As to bridge the gap, structured training is necessary. Detailing of orientation/training programme is to be done as per specific requirements of an Organization.

CHAPTER 5

TRAINING AT MIDDLE LEVEL

5.1 The Middle Level Professionals are at the cutting edge of implementation of highway projects. The Officers of this level whether, working for Government or for Consultants and Contracting Firms are sufficiently experienced and involved in detailed application of Standards and Specifications, Scope of Work and Contract Conditions etc. They are also responsible for quality control, payments, dispute resolution, evaluation of risk sharing between contracting parties and related aspects of execution of the project. Middle Level Managers like Project Engineers also provide communication link between Senior Level and Field Level Officers. Junior Level Officers are mainly concerned with the project preparation and implementation.

5.2 Middle Level Professionals are directly associated with day to day activities related to the project. They should be thorough in the Standard Specifications for Road and Bridge Works. Sound knowledge and understanding of road work, particularly relating to site clearance, earth work, erosion control, drainage, sub-base & base courses (non bituminous), base & surface courses (bituminous), concrete pavement, traffic signs, pavement markings, other road appurtenances, quality control etc. is necessary for these Professionals. They should also have sound knowledge of bridge work, related to materials, different types of foundations for bridges such as pile, well and open foundation, brick and stone masonry, form work, steel reinforcement, steel structures, concrete, pre-stressed concrete, bearings, expansion joint, substructure, wearing coat, river training works and protection work. They should also have knowledge of design principles of road tunnels, geotechnical surveys, alignment surveys, equipment used for tunneling, tackling seepage in tunnels, maintenance of tunnels etc. They should also have knowledge of other works viz. pipe culvert, reinforced earth, soil nailing, surface & sub-surface geotechnical investigations. Maintenance/upkeep of the existing roads and bridges is one of the important functions of the Field Officer at site. Therefore, the Professionals should also have knowledge of Specifications for Maintenance, Repair and Rehabilitation of Roads and Bridges.

5.3 Besides Professionals at this level should have updated knowledge of IRC Codal provisions for surface and sub-surface geotechnical investigations, a very important activity for any civil engineering project. Further, they should be acquainted with the latest IT/GPS based survey instruments/tools and capability of understanding working of design software of roads/bridges. They should have clear understanding of Codal provisions of IRC for traffic census and geometric design of the highway alignment for plain and hilly roads. These Officers should have knowledge of guidelines for strengthening of existing pavement (flexible as well as rigid). Soil stabilization is one of the ways to economize use of aggregate by stabilization of sub-grade. Besides, by stabilization thickness of road crust can be reduced to a great extent. The Officers at middle level should be exposed to different Soil Stabilization Techniques and associated Specifications.

5.4 Quality control is a very important activity of the supervision of work. In highway projects, setting up and maintenance of laboratory at site, is the responsibility of contractor. Besides, the Contractor has to conduct quality control tests on materials and workmanship as per the norms stipulated in relevant IRC codes or Standard Specifications. Professionals at this level should be aware about the testing facilities to be set up for road and bridge works and also how to conduct these tests and adhere to laid down frequency of tests. They should also be aware of

the acceptance range of the test results so that works falling short of acceptable Standards can be accepted, rejected or got rectified/redone.

5.5 Officers at this level should have knowledge of design of various components of bridges such as superstructure, sub-structure, foundation, expansion joints, bearings, protection works, hydraulic parameters for design of bridge and geotechnical parameters of the soil. They should also be aware of condition survey techniques, routine inspection and preventive action as a number of existing old bridges on the road network have outlived their service life and the same are required to be maintained in traffic worthy condition till their reconstruction. Regular repair/rehabilitation of these bridges is necessary and the Professionals of this level should have knowledge of repair and rehabilitation techniques/methodology as well as non destructive testing methods for assessing the conditions of bridges.

5.6 Road safety is another issue of concern as accidents are taking place even after construction of good quality roads and modern vehicles having high safety features. In order to minimize accidents, safety aspects have to be taken into consideration at design, execution and operation stages of the highway project. The Professionals at this level should have knowledge of safety aspects related to highways and bridges. In fact, Professionals of this level should be trained as Road Safety Auditors. Road safety during construction, particularly in urban areas having space constraint, is crucial. They should also be aware of the safety standards for the personnel working at site.

5.7 Although the Professionals at this level are not involved in the planning, policy and management of the highway, but, they should have exposure to the long term planning, current policies and management strategy of the highway sector in the country in general and of their organization in particular. They should also be capable of evaluating Detailed Project Report/ Feasibility Report for the highway project based on which the decision on the project is taken at higher level. Nowadays, DPR for the project is being prepared by the Consultants engaged by the Employer under the broad supervision of the employer. Professionals at this level should be aware of different stages of DPR and their duties as Employer's representative at site. Inputs from this level are very crucial as these Professionals are at site and therefore, they are acquainted with site constraint/condition and can devise practicable solutions suited to the site.

5.8 These mid-level Professionals are sometimes posted for corridor management of NHs/Expressways/ other highways and therefore, should be aware of the corridor management concept, asset management of highways, highway aesthetics and issues related to ribbon development.

5.9 These mid-level Professionals directly deal with matters/issues related to land acquisition, encroachment. Therefore, they should have in-depth knowledge of various Acts, such as NH Act, NHA Act, CRF Act, LA Act, CMV Act, Land Acquisition Act, Arbitration and Conciliation Act, GFR, Basic accounting & Finance etc.

5.10 The mid-level Professionals at this level should have broad knowledge of different modes of contracting work such as PPP, EPC, Annuity, Hybrid, Percentage Rate, Item Rate, and their suitability under a particular scenario. They should also have broad idea about the Standard Bidding documents for these different modes of contracting and the procedures/guidelines of funding by the multilateral agencies such as World Bank, ADB, JICA, etc.

5.11 The mid-level Professionals should have in-depth knowledge of Project Management Techniques, International Codes & Practices, Arbitration and Contract Concession Documents for highway construction operation/maintenance and consultancy services for DPR/FS and supervision consultancy/Independent Engineer. Being at site, contract related issues are initiated and dealt with at their level and based on their input /report, decisions are taken at higher level. They should have knowledge of dispute redressal mechanism/Arbitration and Conciliation Act to deal with the project related disputes

5.12 This is the level at which payments are released to Contractors/Consultants and therefore, they should be acquainted with Manual of Disbursements and other related Guidelines.

5.13 These mid-level Professionals should also be aware of the human resource development in highway sector. The Officers at this level being at site and should be aware of non-availability/scarcity of skilled workmen/supervisors. Therefore, they should know as to how to avoid poor quality/workmanship. These Officers should plan and initiate action for getting training imparted to the unskilled /semi skilled Workmen and Supervisors at work site.

5.14 These mid-level Professionals should be aware of the latest R&D practices in highways sector as they are the right persons for providing feedback on the new materials/techniques used at site. MoRTH has allowed new materials/technology accredited by IRC on NHs on trial basis so that based on their performance, the new materials or technologies can be included in the Ministry's Specifications for Road and Bridge Works. In this regard, feedback from these field officers is very important for development of new materials/technologies.

5.15 Professionals of this level are associated with highway project right from inception to completion of the project and therefore, feedback on design, execution and operation from Officers of this level is a vital source for upgradation/revision of IRC Codes/Guidelines/Ministry's Specifications for Road and Bridge Works.

CHAPTER 6

TRAINING AT SENIOR LEVEL

6.1 The Professionals serving as interface between middle level and the top level are not directly involved in policy planning but rather supplement the top level in somewhat more technical way by supplying needed inputs as obtained from field agencies. At this level professional have wide technical and managerial exposure by way of having served at the lower and middle levels. At the same time, they are also aware of current trends of highway development planning and strategies which are being formulated at the top level. They are expected to fuse their technical and administrative acumen to translate objectives into goals.

6.2 Professionals at this level should have knowledge of highway policies, planning and management. They should be aware of the broad policies such as legal framework for road Development and Maintenance, Policy for the ownership of different categories of roads and responsibility of different agencies involved in road development. They should also be aware of current issues related to highway sector such as environment management plan, goals and achievements of the highway sector, corridor management, highway aesthetics, Land Acquisition Act as also Resettlement, Rehabilitation and Disaster Management etc.

6.3 Financial management is also an equally important dimension of a project. The Professionals at this level should have knowledge of emerging financing avenues for road projects such as road fund, private financing, vehicle tax, cess on fuel, project evaluation techniques and financial aspects of corridor management plan. They should be capable of evaluating Detailed Project Report of a highway project based on the technical and financial perspective. The Officers at this level should have knowledge of developing data network using Geographical Information System (GIS) including software operation, the digitization of data and map evaluation for alignment finalization. The Officers should have knowledge of concept of road assets and their maintenance and engineering and non-engineering aspects of the corridor management. They should be aware of planning, design and operation of Expressways, NH and SH corridors Urban Roads and life cycle costing of the assets etc. They should be update with latest R&D in highway sector so that latest and innovative materials available can be utilized and their performance evaluated.

6.4 The Professionals at this level should be aware of the current scenario of human resource development in the highway sector and the need of training/skill development of workers/supervisors and other field staff. Since these Professionals are overseeing execution, they are in a better position to understand the problem of non availability/shortage of skilled Engineers, Staff. Therefore, these officers should have knowledge of training requirements of Middle/Senior Level Officers and unskilled/semi skilled Workers at project site. As per specific requirements, they should be able to get training organized in effective manner so as to improve quality of delivery of road projects.

6.5 Since, these Professionals are doing contract management including monitoring of disbursements to the executing agencies, they should have sound knowledge of funding, disbursement, utilization, reconciliation and maintenance of records. They should have

knowledge of guidelines and procedures of multilateral funding agencies like ADB, WB, JICA, etc. in highway sector. Since this level is directly/indirectly involved in procurement of works and services, they should have idea of different types of bid documents such as PPP, EPC, Annuity, Hybrid, Percentage Rate, Item Rate Contract. Besides, they should also have knowledge of Model Concession Agreement, RFQ. They should be able to suggest a particular mode of execution most suited to prevailing conditions for a particular project. These Professionals have to oversee and monitor the contracts and related activities and, therefore, they should be well versed with provisions of the contract agreement, as the proposal of contract related issues are dealt with at their level for submission to headquarters for the purpose of approval.

6.6 Specifications for Road and Bridge Works is basis for execution of works and, therefore, the professionals at this level should have in-depth knowledge of the same and be capable of correct interpretation of its provisions so as to oversee the speed/progress of work of Contractors, Supervision Consultants/IC/DPR Consultants and other Government Departments. In order to get the work executed as per Specifications, they should have good idea of quality control and quality assurance as per the contract document.

6.7 Bridges are vital link of the highway network. They require higher level of expertise. In order to maintain the existing bridges and construction of new bridges, the Officers at this level should have adequate knowhow of condition survey and rating of bridges as also design and supervision of bridges. Further, the Officer should also have knowledge of routine inspection/maintenance of bridges as per the Bridge Manual of IRC. These Officers should be made aware of different construction methodologies and of factory finish products for faster construction. Modern fabrication techniques for steel bridges/composite bridges should also be known to them. Design of bridges using different modern day software, bridge management system for optimal utilization of limited resources and maintaining Bridge Register using IT tools should also be made known to them.

6.8 Scenario on tunnel construction in India is catching up with the advanced countries due to constrain of road space in urban areas and the need to improve connectivity with remote hilly areas. Officers at the senior level should have knowledge of options/warrants of road tunnels, design principles of road tunnels, geotechnical surveys, alignment surveys, equipment used for tunneling, tackling seepage in tunnels, maintenance of tunnels and about Standards and Specifications to be incorporated in the tender documents.

6.9 Modern construction is machinery oriented. The Engineers at this level should have working ideas of different types of Modern Plants and Machinery. Optimum capacity, functions, comparative advantages and disadvantages of different variants should also be known for efficient project management. Evaluation of requirement of plant and machinery for a particular project and activities is also required to be imparted to this level. They should also have knowledge about upkeep and maintenance of plant and machinery.

6.10 Road safety should be addressed at planning design, construction and operation stages of the highways and bridges. The Officer should be aware of Road Safety Provisions/Guidelines/IRC Manual/Codes, Road Safety Audit etc.

6.11 The Professionals at this level should also be acquainted with latest provisions of NH Act, NHAJ Act, CRF Act, CMV Act, Highway and Land Control Act, Arbitration and Conciliation Act, related Labour Laws, legal framework for dispute resolution and related rules.

6.12 Quality of DPRs, Unwarranted investigations, Technology foresight, Speedy & Quality Construction etc. shall be the focus of training at senior level.

CHAPTER 7

TRAINING AT TOP LEVEL

7.1 Top level includes Officers/Engineers/Administrators/Managers, occupying senior and top level positions and are involved in policy planning and development of highway sector. A top level functionary should be in tune with and capable of visualizing the requirement of road infrastructure of the country in the long term keeping in view of the global economic development scenario. They should be able to visualize the inter sector requirement of transport demand to transform the country in developing its economy for betterment of masses. Efficient road transport sector should be able to function across different transportation modes like shipping, waterways, railways, civil aviation etc. They should also be capable of analyzing the overall demand for quality road infrastructure.

7.2 This level includes (i) Chief Engineers and above level in the Ministry/BRO/ State PWDs, (ii) CGM and above level in NHAI and other organizations, (iii) Secretary level in Ministry/ State PWDs and (iv) equivalent levels in Consultant, Contractor and Concessionaire Organizations. This is the level at which policies are framed and decided. The Officers at this level are involved in policy making, planning and managements associated with Highway Sector. Therefore, they should have idea of Road Development Plan (20 years as well as 5 year Plans) and road development scenario globally with specific reference to developed and developing economics. They should also have idea of broad policies and framework for the road development and maintenance such as NH Act, NHAI Act, LA Act, Highway Land and Traffic Control Act, CRF Act, Central Motor Vehicle Acts, Arbitration and Conciliation Act and related rules etc.

7.3 Roads of different categories Expressways, NH, SH, MDR, ODR, Urban and Rural Roads are developed and maintained by different Govt. agencies (State PWDs, State Development Authorities, NHAI, BRO, Municipal Corporations, NHIDCL etc. The top level Officers should have clear understanding of policy for ownership and responsibility of different agencies for different categories of roads. Understanding of the role and responsibility at different levels of hierarchy and that of Contractors/ Consultants is also required. Similarly, imparting idea of institutional framework apart from mainstream Engineering, like different divisions i.e. Administration, Finance, Audit, Vigilance, their roles, responsibilities and their limitations for development and maintenance of infrastructural assets, ROW, Building Line, Control Line etc. cannot be lost sight of. This is the level at which issues would be sorted out expeditiously if appropriate training is imparted and the Officials are having clear understanding of issues. Therefore, they should be made aware of the current issues pertaining to this sector, working framework for safeguarding the road assets, keeping ROW free from illegal occupation/encroachment, framework for ribbon development control, procurement of aggregate/material for road construction in the present day context relating to Environment and Forest Acts, relevant rulings of National Green Tribunal and Supreme/ High Court rulings. Some Road Projects require clearance from Department of Forests and Environment/ Wild Life Authority. They should be well conversant with the laws/ rules related to Environmental clearance, National Green Tribunal, Wild Life clearance, Supreme Court rulings on environmental issues and environment management plan for developing highway network.

7.4 Most of the projects involve land acquisition and displacement of the people. Thus, this is one of the most important parts of the Highway Planning in the present day context. Therefore,

these Officers should have an idea of Land Acquisition Policies, Acts, Rules, Rehabilitation and Resettlement policies of the country as well as that of WB, ADB and JICA etc. This Level Officers should also have knowledge of Disaster Management Policy related to Highways in case of natural calamities such as flood, earthquake, Tsunami, land slide etc. They have to work for institutional development with permanent establishment as also arrangement for modern machinery and IT facility, to cater to the need of hour.

7.5 These Officers should be aware of corridor management aspects of highway and development planning in tandem with development plans of agencies of other modes of transportation for efficient utilization of limited resources. The Officials at this level should be aware of Financial Management such as emerging financing avenues, project evaluation technique involving project Financial Internal Rate of Return (FIRR), financial aspects of corridor management, standardization of financial model for efficient and transparent evaluation of the highway proposals. They should also have knowledge of engineering, management and planning involving different transport modes, coordination, integration of the road transport with other modes of transport such as Railways, Ports, Waterways, and Airports etc. The Officer should also have clear understanding of concept of road assets, its maintenance, and concept of corridor management including both engineering and non-engineering aspects like highway aesthetics. For growth of any sector, R&D has to play an important role. Hence, the top level should have idea about the R&D needs in the Highway Sector and new materials and innovative technologies being used in the Highway construction. Further, standardization in Highway Sector such as type design of bridges/roads, Standard Manual, Standard Bidding Document (RFQ/RFP) etc. expedite the pace of work in the Highway Sector. Therefore, this level should be capable of appreciating the need of standardization in the sector.

7.6 Human Resource Development and management is an important aspect of any sector. This is the tool to implement the policy and executing the works. This includes development of manpower from labours at ground to top level managers. These Officers should have knowledge of current Human Resource Development of the Highway Sector and be aware of shortage of skilled Workmen/Highway Professionals. The general quality seen all around in the country needs further improvement. These Officers should be aware of career development for Highway Professionals, planning strategy in highway sector and skills development strategies of workmen in the Highway Sector to address the present & future challenges.

7.7 This level should be well conversant with the General Financial Rules of Govt. of India and all other funding agencies across the sector. Comparative analysis of financial rules being followed across the infrastructure sector should be imparted to this level for uniformity and transparency. Like other Government Departments, the works in highway sector are also executed through agencies based on the competitive bidding. The Officials at the top management level should have knowledge of different modes of delivery of public works relating to highway sector, framing policy guidelines for selection of mode of delivery like, Item Rate Contract, EPC, PPP (BOT/annuity/semi-annuity), hybrid etc. They should be aware of institutional set up for project financing in the country, financial approval/sanction, monitoring mechanism for project expenditure, budget provision, control, disbursement system, GFR, Legal Provision in Companies Act, Audit rules, etc.

7.8 After award of the project, the work is executed as per the Contract Agreement entered into between the agency and the Employer. The contract management is done as per the provision of the contract agreement. The Officer should have knowledge of Contract Documents/Guidelines of CPWD/NHAI/State PWDs/Railways/Irrigation and other infrastructure related departments and their relative merits and demerits. They should also have thorough knowledge of FIDIC conditions of Contract and Contract Documents of multilateral funding agencies such as World Bank, ADB, JICA etc.

7.9 Concepts for planning design and execution of urban roads are different from that of interconnecting roads in the country. The Officer should have knowledge of development of corridors based on scientific capacity studies, modalities for selection of grade separators, option/warrant of tunneling, segregation of slow moving/fast moving traffic from motorized traffic, encroachment on ROW etc.

7.10 IT and ICT solutions have been developed for various office related activities such as design and drawing software, project management, modern day communications, and records management software etc. Circulars, Guidelines, Codes, Project Database such as Drawings, DPR, and other relevant details are to be made available on the website for transparency and betterment of profession. The Officers at this level should be aware of these modern tools for efficient functioning.

7.11 Above mentioned topics are required be covered in the training modules for top management level who are decision makers in the framework of the Government. The training in this field would enhance the quality of decision making in the Government in the highway sector. Comprehensive training needs to be imparted to top level Officers so that the highways sector keeps pace with changing times.

7.12 Policy Trends, Government Priorities, Co-ordination, strengths and conflict of interest amongst multiple department and agencies etc. shall be given prime importance.

CHAPTER 8

ORGANIZING TRAINING

8.1 Training Areas as brought out in this document covers highways sector. Therefore, Government Organizations, Public Undertakings, Private Construction Companies, Consultancy Firms and other organizations related with this Sector should consider organizing training courses with the help of details given. The HR Department of an organization has to develop details for training to be imparted to different professionals at top to junior most level. In case in-house Training facilities are available in the organization, it should plan training activities, in consultation with top management and HR Department. In case, the Organization does not have training facilities, the HR Department should nominate one Middle Level Professional as training coordinator who should work under the direction of one senior level nominated for this purpose by the Government/Private Sector. The training may be organized at IAHE, CRRRI, IITs/ NITs/IIMs etc.

8.2 As per objectives of the Organization, it is necessary to establish training needs. That is, at different level and for different tasks to be performed by Professionals, details of training needs should be worked out. Training Areas, given in different chapters will help in working out training needs. Any subject not mentioned in this documentation can also be included under training needs. In order to give guidance for working out training programmes, broad concept of training programmes and their duration has been brought out to be minimum. This should be reviewed, modified and enhanced as per specific requirement.

8.3 Training after joining the Organization: Chapter 4 gives details of areas which should be included in entry level training. The period for class room training can be three to four months. Thereafter, trainees should visit and learn from Incharge of different units of the organization. For each unit 3 days to 6 days are considered adequate. Trainees should record notes, which should be reviewed by training Incharge. Total training period at entry level should be at least six months, depending on necessity of organization.

8.4 Training on promotion: After promotion to higher level, there is a need for change in outlook and widening of horizons. Besides, shift has to be from detailing to comprehensive outlook. One who has worked at junior level, has to think beyond for achieving objective of the Organization. Training Areas have been brought at in **Chapters 5, 6 and 7** for Junior/Middle level, Senior level and Top levels respectively. Depending on necessity of the organization, training subjects and duration should be selected. This training should be of one to four weeks duration.

8.5 Training for Specific Job Requirements: At times, specific tasks are to be performed such as procurement of equipment, scrutiny of International and bi-lateral proposals, new technology etc. For such assignment, it is necessary to impart specialized training to selected individuals. Besides, whenever someone is shifted from one department to another department dealing in different type of tasks, training should be imparted. At times, for design work, specific specialized training is necessary. After induction training, at least 2 trainings per year of one week duration, is a must for all the professionals.

8.6 Project Specific Workshops: It is necessary that project specific workshops are arranged as per necessity of the project. This includes different aspects such as safety, value engineering, quality systems etc. Such workshops should normally be multi-level and multi-disciplinary.

8.7 Planning of Training Programmes: For Organizations having training institutes, training programmes for whole year can be planned, with faculty within training institute, within Organization or external. Where training institutes do not exist, this exercise has to be done by HR Department. While planning training programmes, help of other training institutes may be taken. The Indian Academy of Highway Engineers (IAHE) should play an important role and its training programmes to be dovetailed with training needs of Organization. Similarly, CRRRI is also organizing training programmes which are to be shared for the benefit of Organizations.

8.8 Certifications: Certification for training should be correlated to increments and promotions, as per specific necessity of an Organization. Basically training is to be taken seriously by individuals for their career development and also for growth of the Organization.

8.9 Nominations for Seminars, Workshops, and Conferences at National/International level shall be considered as a part of training. Encouragement & Incentives to be given to Professionals/Engineers who are interested in R&D. They may be given an increment, study leave, early promotions, tours/emoluments on the basis of achievement and contribution made to the Organization.

TRAINING AREAS FOR PROFESSIONALS

1. Planning & Development

- i) Historical background, different categories of roads in the network and their role/ Guidelines for Mega Projects like -NHDP, SHDP, PMGSY etc.
- ii) Mode of Transport – Intermodal Transport- Road Development/Planning related.
- iii) Broad policy and Legal Frame Work for Road Development and Maintenance.
- iv) Policy for the Ownership and Responsibility of different Road Categories.
- v) Current issues in Highway Sector Development.
- vi) Road Development Plans (20 year and 5 year plan) in India including changing emphasis in planning and technology and their causative factors- to understand present development scenario and future scheme of things, keeping of the records, drawings, deliberations etc. in the modern Day IT environment. Long term road plans, directions, goals, targets v/s achievements, overall coordination of agencies w.r.t. their development plans.
- vii) Road development scenario globally with specific reference to developing economies, treaties and cooperation with developed and developing Countries for technology transfer/ upgradation etc. assisting developing countries.
- viii) Broad policy and legal frame work for road development and maintenance (NH Act, NHAI Act. LA Act. Highway Land and Traffic Control Act. CRF Act, Motor Vehicles Act and Rules, Arbitration and Conciliation Act, Policy framework for linking highways development with GDP of Nation.
- ix) Policy for the ownership and responsibility of different road categories, institutional framework for development and upkeep of assets, ROW, building lines, control lines, 3D concepts of ROW.
- x) Current issues in Highway Sector Development, working framework for safeguarding the assets, keeping the ROW free from illegal occupation, free from encroachments, framework for Ribbon Development Control, Procurement of Materials.
- xi) Environment Management Plan for developing Highways Network, Environmental Laws, National Green Tribunal, Environment and Forest Clearance, Wild Life Act, and Clearance, Supreme Court Rulings.
- xii) Land Acquisition, Resettlement, Rehabilitation Policies, Land Records, Revenue Maps and their upkeep, Revenue Maps vis-a-vis Topographic Maps and correctness thereof, latest RR Policies, WB and ADB, JICA Policies.
- xiii) Disaster Management Policies, Special Financial Powers to be delegated in case of disaster, interchangeability of resources in case of disaster.
- xiv) Concepts of Road Assets and Management.

2. Contract Management

- i) Contract Documents/Guidelines of CPWD/NHAI, State PWDs, Railways, Irrigation and other Infrastructure Departments and their relative merits and

demerits, understanding global practices on the subject, emerging trends. FIDIC Conditions of Contracts.

- ii) World Bank, ADB, EPC Guidelines and Bidding Procedures.
- iii) Different types of Model Concession Agreements.
- iv) Quality Control and Quality Assurance in Contract Document/Management.
- v) ISO System, QA and QC at Work Site.
- vi) Productivity Management of Equipment and Machinery.
- vii) Dispute Resolution of Construction Contract, Consultancy Services Contract, Contract on BOT; Operation & Management (O&M) Type Contract.
- viii) Contract Management, enforcing Contract Conditions and Administration of Fixed Price Contract, FIDIC, WB Guidelines based Contract.
- ix) Procurement, Procedure of Goods and Services like Machine and Equipment, Contracting Parties, Consultant.
- x) Interpretation of Contract Clauses including conceptualization of risk sharing and obligation of Contracting Parties for different types of Goods and Services.
- xi) Developing innovative non schedule items, Rates and Rate Analysis, Special Conditions and Particular Specifications.
- xii) Productivity Management of Equipment and Machinery.

3. Pavement Evaluation, Performance and Management

- i) Types of Pavement, Evaluation of Pavement, Axle load, Evaluation Techniques etc.
- ii) Road Condition Survey for Assessment, Evaluation, Development, Strengthening and Maintenance Strategy.
- iii) Disseminating experience on Pavement Performance using different Materials, Admixtures, Fillers as to their merits and demerits, Deterioration Models, Inventory, Condition Survey.
- iv) Intelligent Transport System with objective of Safety, Efficiency, Productivity and Environment Protection.
- v) Pavement Rehabilitation Programming.
- vi) GIS and Pavement Management.
- vii) Road Performance Parameters/Serviceability of Roads of different types like Bituminous, Concrete etc.
- viii) Evaluation and Social Assessment of Highway Project.
- ix) M&R Techniques.

4. Instrumentation and Micro-processor Applications

- i) Different types of Instrumentation, their calibration as used in Roads, Bridges and Flyovers.
- ii) New Generation Microprocessors for Pavement Evaluation like Nuclear Density Gauge etc.

- iii) New Generation Instrumentation for Traffic Studies.
- iv) Computer Aided Designs.
- v) Advanced Analysis of Road and Bridge Structures.
- vi) IT, GIS, GPS in QC and Work Computation.

5. Location, Geometrics and Drainage

- i) Roadway Survey Methods, Total Station Survey, Lidar, Satelite, Aerial Survey.
- ii) Geometric Design of Roadway/Highway facilities.
- iii) Planning and Designing Road Drainage System.
- iv) Highway Drainage, Sediment and Erosion Control.
- v) Surveying and Computation of Highway Alignment.
- vi) Coordination of Alignment, Profile and Super Elevation.

6. Pavement Engineering and Materials

- i) Conceptualization and Evaluation of Parameters relating to Pavement Design as covered in MoRTH and MoRD Specifications.
- ii) Hill Roads Maintenance Problems and Solutions.
- iii) Different types of Pavement Materials, their engineering and environmental properties, their testing etc.
- iv) Soil Stabilization Techniques to improve CBR value of soil.

7. Flexible Pavements

- i) Design Philosophy.
- ii) Conceptualization of Parameters relating to Flexible Pavement.
- iii) Earthwork, Subgrade, Granular Subbase, Wet Mix Macadam.
- iv) Bitumen and Bituminous Mixes- Multigrade Bitumen, Porous Asphalt, Warm Asphalt, PMB, NRMB, CRMB, Cold Mix Technology, Emulsion etc.
- v) Bituminous Overlay – their types, Mix Design, Technology and QC aspects.
- vi) Maintenance Strategy including Assessment and Evaluation of Pavement Condition.
- vii) Bituminous Paving Machine and Equipment.
- viii) QA Plan for Hot Mix Plants.
- ix) Global scenario on Flexible Pavement, i/c Design, Construction Methodology, Repair and Maintenance, Drainage aspect etc.

8. Rigid Pavements

- i) Design Philosophy.
- ii) Conceptualization of Parameters relating to Rigid Pavement.
- iii) Concrete Technology as relevant to Rigid Pavement.
- iv) Rigid Pavement Overlay – their types, Technology and QC aspects.

- v) Maintenance Strategy including Assessment and Evaluation of Pavement Condition.
- vi) Rigid Pavement Laying Machine and Equipment.
- vii) Rigid Pavement Repair System, Maintain, Repair, Rehabilitation & Strengthening Techniques.
- viii) Global Scenario on Rigid Pavement, i/c Design, Construction Methodology, Repair and Maintenance, Usage of different types of Admixtures, High Performance Concrete etc.
- ix) Methodology of Repair and Maintenance and usage of different types of Admixtures; High Performance Concrete etc.

9. Geotechnical Engineering

- i) Geotechnical Investigations.
- ii) Landslide and their Mitigation Measures.
- iii) Hill Road Construction and Monitoring of Slope Stability including usage of relevant Instrumentation Technology, Bio-Engineering Measures.
- iv) Failure of Slopes, Pavements etc.
- v) Soil Engineering for Road Design.
- vi) Landslide Investigation.
- vii) Ground Improvement Techniques and Monitoring Consolidation Process.
- viii) Conceptualization of Geotechnical Parameters for Bridge Engineering.
- ix) Ground Improvement Techniques and Soil Reinforcement Structure.
- x) Soil Engineering for Highway Design.

10. Bridge Engineering

- i) Conceptualization of Parameters used in Planning and Designing Bridge Structures.
- ii) Bridges and Flyovers Aesthetics.
- iii) Designing Bridge Foundation and Sub-Structure
- iv) Design of Bridge Superstructure.
- v) Standards and Specifications and incorporating them in Contract Document for Bridge Structures.
- vi) Global Scenario on Bridge Construction Techniques and Technologies.
- vii) Bridge Construction, Maintenance Equipment and Machinery.
- viii) Bridge Construction Methodology, Testing and Calibration of Instrumentation etc.
- ix) Inspection of Bridges, their Distress and Remedial Measures.
- x) Case Studies of Segmental Bridge Construction.
- xi) Investigation aspects of Bridge Site.
- xii) Designing Bridge Foundation of various types.
- xiii) Design of Bridge Superstructure of various types.

- xiv) Performance Evaluation and Bridge Maintenance Management System.
- xv) Bridge Construction Methodology, Testing and Calibration of Instrumentation etc.
- xvi) QC Aspect of Bridge Construction.
- xvii) Inspection of Bridges, their Distress and Remedial Measures.
- xviii) Performance Evaluation and Bridge Management.

11. Tunnel Engineering

- i) Scenario on Tunnel Construction in India (Roads, Railways, Power Plants, etc.)
- ii) Alignment Survey, Geometric Design and Standards.
- iii) Geotechnical Surveys and Investigations.
- iv) Design Principles of Road Tunnels.
- v) Standards and Specifications and their incorporation in Contract Documents.
- vi) Tunnel Boring Machines, other methods of Excavation and Equipment for Tunnels.
- vii) Methods of Excavation and Equipment for Tunnels.
- viii) Lighting of Tunnels, illumination levels within and approaches to Tunnels.
- ix) Escape System for long Tunnels.
- x) Measures for Drainage/ Seepage in Tunnels.
- xi) Quality Control during Execution.
- xii) Safety in Work Zones.
- xiii) Maintenance of Tunnels.

12. Urban Roads

- i) Urban Roads; their Characteristics, Special needs.
- ii) Urban Road Planning based on Traffic Data and Urban Master Plan considerations.
- iii) Geometric Design of Urban Roads of different categories.
- iv) Instrumentations for Monitoring Traffic and Traffic Studies for Urban Roads.
- v) Urban Road Drainage System.
- vi) Multimodal Transportation System for Urban Areas.
- vii) Ducts for Laying utilities & other Services.
- viii) Urban Civic Amenities like Parking and Terminals, Pedestrian and Cycle Lanes etc.

13. Transportation Planning & Traffic studies

- i) Transportation Planning Process.
- ii) Traffic Engineering Studies- Volume, Travel Time and Delays etc.
- iii) Evaluating Transportation Alternatives.
- iv) Highway Capacity Augmentation and Congestion Determination.

- v) Design of Signals, Traffic Flow Studies, Intersection (at-grade) and Interchanges, Flyovers.
- vi) Design of Road Signage, Safety Devices, Pavement Markings etc.
- vii) Capacity and level of service for different Highway Categories.
- viii) Capacity and level of service at Signalized Intersections.

14. Safety and Environment

- i) Environmental Impact Assessment (EIA), Social Impact Assessment and Environment Management Plan Safety aspects of Road and Bridge Design.
- ii) Safety aspects during Construction of Roads and Bridges.
- iii) Road Accident Modeling for different types of Roads.
- iv) Road Fixtures and Pedestrian Safety.
- v) Safety and Traffic Management at Construction Sites (Work Zones).
- vi) Environment Protection
- vii) Environmental Management Plan of Highway Projects.
- viii) Noise and Air Pollution and their Mitigation Mechanism.

15. Statuary & Legal

- i) Highway Legislations: NH Act, NHA Act, CRF Act, MV Act etc. including Highway Administration as relevant to various Highways Legislations.
- ii) Ribbon Development and Encroachment Issues, Environmental & Forest Issues, Land Acquisition etc.
- iii) Inter-Ministerial Approvals/Clearances like GAD etc.
- iv) Legal Framework for Dispute Resolution.
- v) Legal Framework for different types of Contracts, Concession Agreements, BOT & O&M Instruments i/c FIDIC and WB Contract etc.
- vi) National & International Labour Laws.
- vii) Total Quality Management and ISO Certification.
- viii) Tolling & Toll Act

16. Highway & Bridge Maintenance and Management

- i) Maintenance of Roads & Bridges Covering its Technical Aspects and Operational Capacity Issues.
- ii) Operation and Maintenance of Highways i/c Tolling System covering Electronic Toll Collection (ETC).
- iii) Wayside Amenities on Expressways, Toll Plaza, Planning and Design etc.
- iv) Maintenance Administration-Road Side, Drainage, Weather related issues.
- v) Highway Landscaping and Horticulture Works.
- vi) Asset Management.
- vii) Pavement Management System, Bridge Management System, Structural Health Monitoring & Rehabilitation.
- viii) Software for Pavement & Bridge Management.

- ix) Software like HDM 4 for developing Maintenance Plan for RR, DR, MDR, SH and NH.
- x) Developing Road Inventories and Road Information System for both Intercity Areas and Urban Roads for chalking out their Maintenance Management Strategies.
- xi) Value Engineering/LCC/Optimal Utilization/Risk Analysis.
- xii) New Material & Techniques.
- xiii) Quality Assurance & Technical Audit.
- xiv) Safety Audit.
- xv) Mechanization in Highway Projects.

17. Funding Agencies

- i) Road Project Funding, their Disbursement, Utilization and Reconciliation.
- ii) Funding Agencies like ADB, WB Guidelines and Procedures including related Policy Planning aspects of Contracting Industry in Road Sector.

18. Use of Modern Technology in Highway Sector

- i) Planning of Road Network.
- ii) Modern Survey Techniques.
- iii) Use of GPS, GPR, Lidar, Satellite, Drones and similar Techniques.
- iv) Feasibility and DPR Studies.
- v) Monitoring Project during Execution.
- vi) Monitoring the Operation of Highways.
- vii) Toll Information and Road Information System.
- viii) Automated Survey Vehicles.
- ix) Mobile Bridge Inspection Units.
- x) Recycling of Pavements.
- xi) Mechanized Maintenance.
- xii) Intelligent Transport System (ITS) & Electronic Toll Collections (ETC).

19. Construction Trades and Equipment

- i) Masonry
- ii) Scaffolding Carpenter
- iii) Bar Bender
- iv) Welder
- v) Electrician
- vi) Operation of Construction Equipment such as Crane, Excavator, Roller, Grader, Paver
- vii) Hot Mix Plant
- viii) Batch Mix Plants
- ix) Ready Mix Concrete

20. Bid Instruments (Procurement of Services And Works) and Work Execution, Planning

- i) PPP in Highway Sector including BOT and its variants. Bid Evaluation.
- ii) SPVs, Financial Structuring, experience in Centre and States.
- iii) Pre-Construction Planning and Coordination activities.
- iv) Road Financing Tools like BOT, BOOT, CRF, State Road Funds etc.

21. Financial Management

- i) General Planning, Design & Operation of Expressways.
- ii) DPRs and their Evaluation for Road Network Planning and Design, Bridges, Traffic and Transportation etc. Engineering Management and Planning.
- iii) Developing Network Data using Geographical Information System (GIS), Environment i/c Software Operation, Training on Digitization of Data, Map Evaluation for Finalization of Core Network.
- iv) Corridor Management including Engineering & Non Engineering Aspects.
- v) R&D in Road Sector.
- vi) Life Cycle Costing of Highway Projects.
- vii) Principles of Highway Aesthetics. Integration of Road Designs with Topographical Character of the Surrounding Landscape.
- viii) Emerging Financing Avenues of Roads Construction & Maintenance; Road Fund; Private Financing; Market Committee Fees; Vehicle Taxes; Cess on Fuel
- ix) Project Evaluation Technique involving Project FIRR, Financial Appraisal.

22. Human Resource Development

- i) Career Development in Highway Sector.
- ii) Current Scenario of Human Resource Development in the sector and Identification of Problems of Skill Shortage of available Personnel.
- iii) Organization Development in Highway Sector.
- iv) Engineering Knowledge and Skills Development Strategy.
- v) Workmen Training and Skill Development.
- vi) Understanding the Legal and Institutional set up for Infrastructure in the country, Dissemination of ideas of quality infrastructure and its role in transforming life of masses, importance of role of efficient transport network in economic development of country, understanding the role of quality and standardization in everyday life in general and highway profession in particular, propagation of philosophy of quality and standardization by simplified means in highways sector, Simplification of language of Specifications, Rules, and Codes (so as to have a wider approach in English, Hindi, and other Vernacular languages), making these things available on internet and other means of modern day communication.
- vii) Workmen Training and Skills Development Strategies through ITI's (with changed curriculum as per the requirement of the Highway Construction industry), NGO's and Vocational Training Departments of the state, in the vicinity in the

contractor's campus through audio visual means, making training materials/ manuals available on internet etc.

- viii) Foreign Training
- ix) Ethics and Human Values
- x) Meditation Techniques
- xi) Time Management

23. Administrative Issues

- i) Office Procedure and Conduct Rules
- ii) Noting/Drafting/Communications
- iii) Parliamentary Matters
- iv) VIP References
- v) RTI, Public Grievances, Reservation
- vi) Service Matters

(The Official amendments to this document would be published by the IRC in its periodical, 'Indian Highways' which shall be considered as effective and as part of the Code/Guidelines/Manual, etc. from the date specified therein)

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