JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech in INFRASTRUCTURE ENGINEERING
Effective from Academic Year 2017- 18 admitted batch

COURSE STRUCTURE AND SYLLABUS

I Semester

Category	Course Title	Int. marks	Ext. marks	L	T	P	C
PC-1	Water Resources Systems Planning and Management	25	75	4	0	0	4
PC-2	Construction Management	25	75	4	0	0	4
PC-3	Geotechnics for Infrastructure	25	75	4	0	0	4
PE-1	Building Planning and Construction. Integrated Water Resources Management Ground Improvement Techniques	25	75	**3**	0	0	3
PE-2	Ports & Harbours Construction Techniques Advanced Reinforced Concrete Design	25	75	**3**	0	0	3
OE-1	***Open Elective - I**	25	75	3	0	0	3
Laboratory I	Concrete & Geotechnic Lab	25	75	0	0	3	2
Seminar I	Seminar-I	100	0	0	0	3	2
Total		**275**	**525**	**21**	**0**	**6**	**25**

II Semester

Category	Course Title	Int. marks	Ext. marks	L	T	P	C
PC-4	Retaining Structures	25	75	4	0	0	4
PC-5	Urban/Regional Transportation Analysis and Planning Methods	25	75	4	0	0	4
PC-6	Project Planning & Financial Management	25	75	4	0	0	4
PE-3	Advanced Surveying Waste Management Systems Airport Engineering	25	75	**3**	0	0	3
PE4	Repair & Rehabilitation of Buildings Offshore Geotechnics Advanced Steel Design	25	75	**3**	0	0	3
OE-2	***Open Elective - II**	25	75	3	0	0	3
Laboratory II	Software Lab	25	75	0	0	3	2
Seminar II	Seminar-II	100	0	0	0	3	2
Total		**275**	**525**	**21**	**0**	**6**	**25**

III Semester

Course Title	Int. marks	Ext. marks	L	T	P	C
Technical Paper Writing	100	0	0	3	0	2
Comprehensive Viva-Voce	0	100	0	0	0	4
Project work Review II	100	0	0	0	22	8
Total	**200**	**100**	0	**3**	22	**14**

IV Semester

Course Title	Int. marks	Ext. marks	L	T	P	C
Project work Review III	100	0	0	0	24	8
Project Evaluation (Viva-Voce)	0	100	0	0	0	16
Total	**100**	**100**	**0**	**0**	**24**	**24**

***Open Elective subjects must be chosen from the list of open electives offered by OTHER departments.**

 # For Project review I, please refer 7.10 in R17 Academic Regulations.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I year I Sem. (Infrastructure Engineering)

WATER RESOURCES SYSTEM PLANNING AND MANAGEMENT
(PC-1)

Course Objective: To impart knowledge water resources planning, management, linear and dynamic programming

Course Outcomes: The learner will be able to programming to water resource planning.

UNIT – I
Introduction: Concepts of systems analysis, definition, systems approach to water resources planning and management, role of optimization models, objective function and constraints, types of optimization techniques.

UNIT – II
Linear programming: Formulation linear programming models, graphical method, simplex method, application of Linear programming in water resources. Revised simplex method, duality in linear programming.

UNIT – III
Dynamic programming: Belman's of principles of optimality forward and backward recursive dynamic programming, case of dimensionality, application of dynamic programming for resource allocation.

UNIT – IV
Non-linear optimization techniques: Classical method of optimization, Kuch-Tucker, gradient based research techniques for simple unconstrained optimization.

UNIT – V
Water –resources economics: Principles of Economics analysis, benefit cost analysis, socio economic intuitional and pricing of water resources.

REFERENCES:

1. "Operations Research" S. D. Sharma Kedar Nath Ram Nath & Co.
2. "Engineering Optimization – Theory and Practice" S. S. Rao New Age International (p) limited, Publishers.
3. Water Resources System Analysis – Vedula & Mujumdar – Tata Mc.Graw Hill Company Ltd. 2005.
4. Water Resources Economics - James & Lee. Oxford Publishers 2005.

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M. Tech – I year I Sem. (Infrastructure Engineering)

CONSTRUCTION MANAGEMENT
(PC-2)

Course Objectives: To impart knowledge on various aspects related to the construction, New Equipment in construction, tender procedures and management aspects in construction industry.

Course Outcomes: The learner will able to prepare the tender for various works, plan for the projects and will be able to manage the resources more appropriative.

Unit – I
Introduction, Construction Sector in Indian and National Development, Role of Government and Construction Agencies, Planning for Construction projects, Project Feasibility Reports.

Unit – II
Project Scheduling, Project management through networks (CPM & PERT), Resource allocation and project updating

Unit - III
Construction Equipment, Time and motion studies

Unit – IV
Management Information Systems in Construction Industry Human Factors in Construction, Environmental Issues in Construction, Material Management, Construction Safety Management.

Unit – V
Tenders, contracts and specifications: Methods of tendering for projects. Different types of contracts. Importance of specifications. Design and construct Tenders, Build operate and transfer contracts – Turn key contracts. Legal problems. Arbitration. Payment schedule. Quality Control in Construction, Construction Disputes and there settlement

REFERENCE :

1. Construction Engineering and Management – S. Seetharaman
2. Construction Engineering and Management – V.K. Shrivastava
3. Construction Engineering and Management – K.L. Purifoy
4. Construction Equipment - Mahesh varma

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I year I Sem. (Infrastructure Engineering)

GEOTECHNICS FOR INFRASTRUCTURE
(PC-3)

Course Objectives: To impart knowledge on site investigation and soil testing methods and design of different types of foundation appropriate to the type of soil for different structures.

Course Outcomes : the learner will be able to design shallow and deep foundations like piles for railway and highway bridges, harbor structures and also sheet piles.

UNIT – I
Site Investigation for Infrastructure Projects: methods of site investigation, types of soil samples and samplers- Geotechnical field testing – SPT, CPT, Plate Load Test, Pile Load Test.

UNIT – II
Shallow Foundations for Railway & Highway Bridges and Port & Harbour Structures: types of foundations, design forces, safe and allowable bearing capacity of shallow foundations, settlement computation;

UNIT – III
Pile Foundations for Railway & Highway Bridges and Port & Harbour Structures: Pile foundations – types, axial and lateral capacity of pile, pile group analysis and pile cap; Introduction to drilled piers, caissons, well foundations.

UNIT – IV
Foundations for Transmission Line, Radar Antenna, Microwave and TV Tower and Chimneys: Introduction, foundations for towers and chimneys, design forces, behaviour of pad and chimney foundations, design of chimney and pad foundations, anchor foundations (rock anchors), design of foundations for towers and chimneys, analysis of raft on pile foundations; design and construction of shallow foundations on rocks.

UNIT – V
Sheet Piles - introduction, types of sheet pile walls, cantilever sheet pile wall, anchored sheet pile wall, stability analysis of anchored bulkhead by free earth support and fixed earth support method, position of anchorage.
Expansive and Collapsible Soil: Difficult soils- loose granular soils, soft clays and shrinkable soils-identification, swell and swell pressure.

REFERENCES:

1. Soil Mechanics and foundation engineering – P. Purushottama Raj, Pearson Education.
2. Construction of marine and offshore structures – Ben C Gerwick, jr., CRC Press, Taylor and Francis Group.
3. Dynamic soil tests and applications – N S V Kameswara Rao, Wheeler Publishing.
4. Pile design and construction practice – M J Tomlinson, View point Publications, Palladian Publications Limited.
5. IS: 4091 (1979) -Design and construction of foundations for transmission line towers
6. IS: 11233 (1985) - Design and construction of foundations forRadar Antenna, Microwave and TV Tower.
7. Principle of foundation engineering – B.M.Das, CENGAGE Learning, Thomson, Brooks/Cole.
8. Foundation Engineering -Varghese, Prentice Hall of India.
9. Foundation analysis and design – J.E. Bowles, McGraw Hill Books Company

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I year I Sem. (Infrastructure Engineering)

BUILDING PLANNING AND CONSTRUCTION
(PE-1)

Course Objectives: To impart knowledge on Planning different types of buildings for various functionalities and to understand different aspects of construction.

Course Outcomes: Upon completion of the course the learner will be able to plan a building for different requirements and will be able to use different materials appropriately.

Unit-I:
Planning of Building Principle of planning of Buildings, Principles of Architectural design –form, function, utility, esthetics. Integrated approach in Built Environment, Building Rules and Byelaws Necessity of laws, plot sizes, road width, open spaces, floor area ratio (F.A.R.), marginal distances, building line control line, height regulation, room sizes, types of area calculations – built-up area, floor area, carpet area, Rules for ventilation, lighting, drainage, sanitation and parking of vehicles ; Landscape elements and elements of interior decoration.

Unit-II
Planning of residential buildings – Load bearing / Framed Structure – (a) Bungalows (b) Row houses,(c) Ownership flats, (d) Apartments.Planning of public buildings Functional requirements of Public buildings. Following types of public buildings may be considered for planning. Educational Buildings, Hostel building with Rector's and servants'quarters, Lodge/Hotel building, Primary Health center with Hospital staff quarters, factory building Administrative block and factory, Bus Stand, Library building, Shopping complex, Health club, Marriage hall, auditorium, multiplex, sports complex, restaurant, vegetable market, post office, bank and any other.

Unit-III
(A) Stones and stone masonry: Stones – Requirements of good building stones IS specification and tests on stones, Stone masonry – principal terms, Detailing of constructions – procedure for UCR and CR masonry, mortar preparation , types of mortar, Pointing – Purpose and types.

(B) Brick and block masonry: Characteristics of good building bricks, IS specifications and test; Classification of bricks silica, refractory, fire etc; Brick work – terms, types of bonds – English, Flemish, Stretcher, Header; Construction procedure, supervision, Openings in walls, mortar preparation; Block masonry – Hollow, solid , cavity wall construction; Scaffolding – types.

Unit-IV
(A) Doors and windows: Functional requirements, materials of doors and windows, types, glazing, method of fixing doors and windows, fixtures and fastenings.
(B) Arches and lintels: Principle of arch action, Types of arches, method of arch construction, centrifugal and renewal. Lintels – necessity and types, chajja / weather shade – necessity and types
(C)Protective coatings: Plastering types and application, mortar; Painting and varnishing, types and application ; White washing, distempering, oil paints ; Wall cladding – materials, methods of fixing, wall papering and glazing work.

Unit - V:
(A) Fire protection: Fire safety – fire load, Grading of occupancies by fire load, considerations in fire, protection, properties of fire resistant construction, wall and columns, roofs and floors, wall openings, fire escape elements.
(B) Building Services : Importance of building services, Constructional requirements for different building serviceselectrical, telecommunication and entertainment services, plumbing services layout of water supply and drainage system, storage and disposal arrangements, septic tanks, garbage disposal arrangement.

(C) Vertical circulation: Considerations in planning , design and construction ; Stairtypes, materials, fire resisting materials, design of stair, details of ramps, ladders, lifts and escalators.
(D) Steel construction: Steel construction – General purpose of steel work, sections for structural; steelwork, method connecting steel sections – bolting, riveting, welding; structural steel member and their connections – tubular structures.

Text Books:

1. Barrid, “Building Construction” Tata McGraw Hill, New Delhi
2. Ghosh, ”Materials of Construction” Tata McGraw Hill
3. Mentt, “Building Design and Constructions”, Tata McGraw Hill (Second edition)
4. Shah M.G., Kale C.M. and Patki S.Y., “Building drawing an Integrated approach to Built enviro nment”, Tata McGraw Hill (Fifth edition).
5. Mentt, “Building Design and Constructions”, Tata McGraw Hill (Second edition)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I year I Sem. (Infrastructure Engineering)

INTEGRATED WATER RESOURCES AND MANAGEMENT
(PE-1)

Course Objectives: To impart knowledge on runoff, discharge measurement, estimation of flood, and flood disaster mitigation measures.

Course Outcomes: The learner will be able to estimate the quantum of water resources from different sources and able to implement and manage water resources effectively.

UNIT – I
Introduction: Definition, concepts of IWRM, approaches to iwrm, components, importance**. Surface water**: Evapotranspiration – Runoff – Hydrographs – Methods of discharge measurement – Estimation of flood – Flood disaster mitigation measures and damage estimation, rainfall-runoff models.

UNIT – II
Surface water: River engineering and river training works – Hydrologic routing – Hydraulic routing – Hydrology of basin management.

UNIT – III
Ground water: Steady groundwater flow towards a well in confined and unconfined aquifers – Dupit's and Theism's equations, Assumptions, Formation constants, yield of an open well interface and well tests.

UNIT – IV
Groundwater: Unsteady flow towards a well – Non equilibrium equations – Thesis solution – Jocob and Chow's simplifications, Leak aquifers, Groundwater basin management.

UNIT – V
Conjunctive use: Concepts of conjunctive use Models, Case studies for IWRM.

REFERENCES:

1. Groundwater by Bawvwr, John Wiley & sons.
2. Ground water System Planning & Management – R.Willes & W.W.G. Yeh, Prentice Hall.
3. Applied Hydrogeology by C.W. Fetta, CBS Publishers & Distributers.
4. Hydrology by Madan mohan das & Mimi Das Saikia PHI Learning Private Limited
5. Ground water Hydrology by David Keith Todd, John Wiley & Son, New York.
6. Groundwater by H.M. Raghunath, Wiley Eastern Ltd.
7. Engineering Hydrology by K. Subramanya, TMH Publishing Company limited,

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I year I Sem. (Infrastructure Engineering)

GROUND IMPROVEMENT TECHNIQUES
(PE-1)

Course Objective: To understand the importance of ground improvement and know various ground improvement techniques available to date, and selecting and designing suitable ground improvement technique for given soil conditions.

Course Outcome: Depending on the site conditions, students will be able to identify suitable ground improvement technique for specific project and its implications.

Unit-I
Introduction to Engineering Ground Modification: Need and objectives, Identification of soil types, In-situ and laboratory tests to characterize problematic soils; Mechanical, Hydraulic, Physico-chemical, Electrical, Thermal methods, etc. and their applications.

Unit-II
Mechanical Modification – Principles of soil densification – Properties of Compacted soil, Compaction control tests, Specification of compaction requirements, Blasting, Vibrocompaction, Dynamic Tamping and Compaction piles.

Unit-III
Hydraulic Modification – Objectives and techniques, traditional dewatering methods and their choice, Design of dewatering system, Electro-osmosis, Filtration, Drainage and seepage control with Geosynthetics, sand drains, Preloading and vertical drains, Electro-kinetic dewatering.

Unit-IV
Physical and Chemical Modification – Modification by admixtures, Shotcreting and Guniting Technology, Modification at depth by grouting, Crack Grouting and compaction grouting, Jet grouting, Thermal Modification, Ground freezing.

Unit-V
Modification by Inclusions and Confinement - Soil reinforcement, reinforcement with strip, bar, mesh, sheet and grid reinforced soil. In-situ ground reinforcement, ground anchors, rock bolting and soil nailing, case studies.

TEXT BOOKS

1. Hausmann, M. R. (1990) –Engineering Principles of Ground Modification, McGraw Hill Publications, New York.
2. P. Purushothama Raj (1995) - Ground Improvement Techniques, Laxmi Publications, India.

REFERENCES:

1. M.P. Moseley and K. Krisch (2006) – Ground Improvement, II edition, Taylor and Francis.
2. Jones C. J. F. P. (1985) – Earth Reinforcement and soil structures – Butterworths, London.
3. K. Krisch & F.Krisch (2010) –Ground Control and Improvement, John Wiley & Sons, 1994.
4. Peter G. Nicholson (2015): Soil Improvement and Ground Modification Methods, Elsevier Publishers

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M. Tech – I year I Sem. (Infrastructure Engineering)

PORTS & HARBOURS
(PE-2)

Course Objective: To impart knowledge on port infrastructure

Course Outcomes: At the end of the course the student will be able to:

- Explain the significance of ports and harbours as a mode of transport.
- Demonstrate the fundamental principles of wave hydrodynamics and port cargo handling.
- Demonstrate the basic design of port layout
- Design, plan and integrate port and harbour infrastructure.
- Explain the construction, maintenance and renovation aspects of ports and inland waterways

UNIT-I

Introduction and Fundamentals: Introduction: Ports and harbours – an infrastructure layer between two transport media, planning of ports and harbours. The fundamentals: Tide and current conditions inside harbour, water circulation; breakwaters, jetties and quay walls; mooring, berthing and ship motion inside the port; model studies, physical and mathematical studies.

UNIT-II

Design Issues and Design Of Port: Infrastructures: Design issues: Sea port layout with regards to (1) wave action (2) siltation (3) navigability, berthing facilities. Design of Port Infrastructures: Design of port infrastructures with regards to (1) cargo handling (2) cargo storage (3) integrated transport of goods, planning multipurpose port terminals.

UNIT-III

Port Operations: Allowable wave conditions for cargo handling, wave conditions for human safety on quays and breakwaters, forcecasting / nowcasting of wave and current conditions for port operations, dredging and navigability, hazard scenarios; VTMS and management of computerized container terminal, safety & environment (handling of fire, oil spill, rescue, etc.

UNIT-IV

Inland Waterways and Ports: Maintenance of waterways, construction of environmentally engineered banks, dredging, and disposal processing and storing of polluted dredged materials, development of river info

UNIT-V

Construction Aspects and Sustainability: Planning and construction expansion and renovation of port and Inland Port Infrastructure. Global trade and port restructuring/reforms, impact of possible climate change scenarios, sustainable development strategies for cities and ports.

TEXT BOOKS

1. Muir Wood, A.M., and Fleming. C.A., “Coastal Hydraulics Sea and Inland Port Structures”, 1st Edition, Hallstead Press, 2002.
2. Ozha & Ozha, “Dock and Harbour Engineering”, 1 st Edition, Charotar Books, Anand., 1990

REFERENCES

1. S. Seetharaman, “Construction Engineering and Management”, 4 thEdition ,Umesh publications, New Delhi, 1999.
2. Richand L. Silister, “Coastal Engineering Volume I & II, Elsevier Publishers, 2000.
3. PeraBrunn, “Port Engineering”, 1 st Edition, Gulf Publishing Company, 200

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M. Tech – I year I Sem. (Infrastructure Engineering)

CONSTRUCTION TECHNIQUES
(PE-2)

Course Objectives:

- Understand the limitations of construction techniques.
- Analyze productivity and economics in construction techniques.

Course Outcomes: The learner will be able to implement modular construction practices. Understand reliable proportioning concepts in construction techniques.

Unit - I:
Introduction: Introduction to Construction Techniques Reinforced and Prestressed Concrete construction, Mechanized methods of earthwork: Tractors and attachments, Dozers, Tippers, Scrapers, Shovels and Trenching machines, Dumpers, Rollers and Compactors, Estimation of quantities of earthwork in grading, Grading of sites with bulldozers and scrapers, Drilling, Blasting methods, Labor protection in drilling and blasting, Fabrication of reinforcement and transportation of erected reinforcement, Concreting, Special methods for concreting construction.

Unit - II:
Introduction to Prestressed concrete, Advantages and Disadvantages of Prestressed concrete, Types of Pre-stressing, Methods of pre-stressing, Equipment for pre-stressing operation. Construction techniques- cantilever construction; staging method, push out technique, progressive placement construction method.

Unit - III:
Prefabricated structures: Introduction to Prefabricated structures, Planning for pre-casting, Selection of equipment for fabrication, Transport and erection of prefabricated components, Quality measures, Design considerations of precast elements, Safety measure during erection

Unit - IV:
Ready mixed Concrete: Production of Ready Mixed Concrete, Site mixed vs. Ready Mixed Concrete, Equipment for RMC plant, IS code provision for RMC, Quality measures of Ready Mixed Concrete, RMC Productivity analysis, Productivity analysis-Case study

Unit - V:
Modular Construction Practices: Introduction to Modular Construction, Modular coordination, Modular Standardization, Modular System Building, Limitation and Advantages of Modular Construction Formwork: Requirements of Formwork, Loads carried by Formwork, Types of Formwork: Timber, Steel, Modular shuttering, Slip forms, Scaffolding.

TEXTBOOKS:

1. Allen E, Iano, J, Fundamentals of Building Construction subscription E Book, Material and Method, John Wiley and Sons, 2011.
2. Cameron K. Andres, Ronald C. Smith, Principles and Practices of Commercial Construction, 8 th Ed., Prentice Hall, 2009.

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M. Tech – I year I Sem. (Infrastructure Engineering)

ADVANCED REINFORCED CONCRETE DESIGN
(PE-2)

Course Objectives: To impart knowledge on the behavior and design on various reinforced concrete structural elements.

Course Outcomes: The learner will be able to design the reinforced concrete elements like beams, slabs and compression members.

UNIT - I

Basic Design Concepts: Behaviour in flexure, Design of singly reinforced rectangular sections, Design of doubly reinforced rectangular sections, Design of flanged beams, Design of shear, Design for Torsion, Limit state of Serviceability: Deflections of Reinforced concrete beams and slabs, short term deflection and long term deflection, estimation of crack width in RCC members, calculation of crack widths.

UNIT - II

Limit Analysis of R.C. Structures: Rotation of a plastic hinge, Redistribution of moments, moment rotation characteristics of RC member, I.S. code provisions, and applications for fixed and continuous beam. Yield line analysis for slabs: Upper bound and lower bound theorems – yield line criterion – Virtual work and equilibrium methods of analysis for square and circular slabs with simple and continuous end conditions.

UNIT - III

Design of Ribbed slabs, Flat slabs: Analysis of the Slabs for Moment and Shears, Ultimate Moment of Resistance, Design for shear, Deflection, Arrangement of Reinforcements.
Flat slabs: Direct design method – Distribution of moments in column strips and middle strip-moment and shear transfer from slabs to columns – Shear in Flat slabs-Check for one way and two way shears - Introduction to Equivalent frame method. Limitations of Direct design method, Distribution of moments in column strips and middle strip.

UNIT - IV

Design of Reinforced Concrete Deep Beams & Corbels: Steps of Designing Deep Beams, Design by IS 456, Checking for Local Failures, Detailing of Deep Beams, Analysis of Forces in a Corbels , Design of Procedure of Corbels, Design of Nibs.

UNIT - V

Design of Elevated intz type of Water Tank **Design of Combined Footings**- Distribution of soil Pressure – Geometry of Two Column Combined Footing – Design Considerations in Combined Footing for Two – Columns.

TEXT BOOKS:

1. Reinforced concrete design by S. Unnikrishna Pillai & Menon, Tata Mc. Graw Hill, 2nd Edition, 2004
2. Advanced Reinforced Concrete Design – P.C. Varghese, Prentice Hall of India, 2008

REFERENCE BOOKS:

1. Reinforced concrete design by Kennath Leet, Tata Mc. Graw-Hill International, editions, 2nd edition, 1991.
2. Design of Reinforced concrete structures by N.Subramanian, Oxford University Press
3. Reinforced Concrete Structures by Park and Paulay, John Willey Publishers.
4. Design of concrete structures – Arthus H. Nilson, David Darwin, and Chorles W. Dolar, Tata Mc. Graw-Hill, 3rd Edition, 2005.
5. Limit state theory and design of reinforced concrete by Dr. S.R. Karve and Dr. V.L. Shah, Standard Publishers, Pune, 3rd Edition, 1994.
6. IS : 456 : 2000, Code of Practice for Plane and Reinforced Cement Concrete,
7. SP 16, SP 34.
8. IS 3370 Part I to Part IV.

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M. Tech – I year I Sem. (Infrastructure Engineering)

CONCRETE & GEOTECHNIC LAB

Course Objectives: To impart knowledge about the different civil engineering materials and understand their behavior.

Course Outcomes: The learner will be able to test and interpret the results of various tests on civil engineering material

1. Compressive Strength of Concrete with Rebound Hammer Test.
2. Compressive Strength of Concrete using Ultra Sonic Pulse Velocity Test.
3. Evaluation of Reinforcement using Rebar Locater.
4. Compressive Strength of rock hardness using Rebound Hammer.
5. To find the Bitumen contents and gradation of the mix.
6. Collection and preservation of disturbed and undisturbed soil samples including advanced bore and identification of relevant tests.
7. Estimation of pollutants using spectrophotometer.
8. Quality control tests at site for construction materials.
   Soil, bricks, concrete, water, steel Bitumen, Sand & aggregates.

9. Any two of the following:

a. DPR preparation for soil investigation for bridge foundation designing.
b. DPR preparation for construction of typical highway.
c. DPR preparation for canal construction.
d. DPR preparation for water supply and sewerage system.

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