STR 440 Design of Reinforced Cement Concrete Structures (3 – 2 – 1)

Evaluation:

	Theory	Practical	Total
Sessional:	30	20	50
Final:	50	-	50
Total:	80	20	100

Course Objective:

The main objectives of this course are to make students able to:

- design simple reinforced cement concrete structures,
- use limit state method of design for beam, slab, staircase, columns, footings and
- perform detailing of various RCC structures.

Course Contents:

1. Introduction **2 hrs**

1.1 Limitation of plain concrete
1.2 Properties of reinforcement and concrete
1.3 Analysis of forces and stresses in reinforced concrete structure

2. Design Methods **5 hrs**

2.1 Working stress method for design of RCC structures
2.2 Ultimate load method for design of RCC structures
2.3 Limit state method for design of RCC structures
2.4 Types of Limit state methods
2.5 Characteristic loads and strength of materials
2.6 Partial safety factors and their considerations in structural design

3. Limit State Design for Beams and Slabs **15 hrs**

3.1 General design considerations
3.2 Analysis of singly and doubly reinforced rectangular beam section
3.3 Analysis of singly reinforced flanged beam section
3.4 Strength and serviceability requirements for flexure members
3.5 Design and detailing of simply supported and continuous beam (for flexure, shear and torsion)
3.6 Design and detailing of slabs spanning in one or both directions

4. Limit State Design for Columns and Footings **12 hrs**

4.1 General design considerations
4.2 Design and detailing of short/slender rectangular & square columns
4.3 Design and detailing of circular column (with circular/helical tie)
4.4 Design and detailing of axially and eccentrically loaded isolated footing
4.5 Design and detailing of combined footing
4.6 Design and detailing of raft (mat) footing

5. Design and Detailing of Miscellaneous Structures **11 hrs**

5.1 Design and detailing of dog legged and open well staircase
5.2 Design concepts and detailing of underground water tank and overhead tank
5.3 Design concepts and detailing of domes, folded plates and Intze tank

Laboratories:

1. Pure bending failure of a beam and its load-deformation characteristics
2. Shear failure of a beam and its load-deformation characteristics
3. Combined bending and shear failure of a beam and its load-deformation characteristics
4. Lap-splice failure of longitudinal bar in beam

Text Books:

1. Jain, A.K. *Reinforced Concrete: Limit State Design*. Roorkee: Nem Chand and Co.
2. Jai, Krishna and Jain, O. P. *Design of R.C.C. Structure*.

References:

1. Introduction (2 hrs)

1. Dayaratnam, P. *Design of Reinforced Concrete Structures*. New Delhi: Oxford & IBH Publishing Co.
2. Sinha, S.N. *Reinforced Concrete Design*. India: Prentice Hall Private Limited.
3. Rao, K. L. *Design of R.C.C. Structures*.
4. Varghese, P.C. *Limit State Design of Reinforced Concrete Structures*. India: Prentice Hall Pvt. Ltd.
5. Kumar, Sujeet. *Concrete Structures-I*. New Delhi: S.K. Kataria& Sons.
6. BIS. *PLAIN AND REINFORCED CONCRETE – CODE OF PRACTICE (IS456:2000)*. New Delhi: Bureau of Indian Standards.
7. BIS. *Design Aids for Reinforced Concrete to IS:456-1978*. New Delhi: Bureau of Indian Standards.

ECO 411 Engineering Economics (3 – 2 – 0)

Evaluation:

	Theory	Practical	Total
Sessional	50	-	50
Final	50	-	50
Total	100	-	100

Course Objective:

After completing this course, students will be able to

- understand and describe the basic concept of economics, engineering economics, cost accounting and time value of money,
- assist in the valuation of engineering projects in the public and private sector to take investment decisions,
- analyze the project risk and understand the concept of ecological limit and economic development,
- calculate depreciation, taxation and its application in analysis and
- identify different financing options and general accounting procedures.

Course Contents:

1. Basics of Engineering Economics **3 hrs**

1.1. Definition of Economics, Demand, the Law of Demand, Law of Diminishing Utility, Marginal Utility, Supply, Law of Supply, Law of Supply and Demand

1.2. Engineering Economics, Principles of Engineering Economy and its application

2. Cost Concept and Fundamentals of Cost Accounting **3 hrs**

2.1. Cost Terminology: Manufacturing Cost and Non-Manufacturing Cost

2.2. Cost for Business Decision: Differential Cost and Revenue; Opportunity Cost, Sunk Cost and Marginal Cost

3. Time Value of Money **4 hrs**

3.1. Interest, Simple Interest, Compound Interest, Nominal Rate of Interest, Effective Rate of Interest

3.2. Economic Equivalence: Present Worth, Future Worth and Annual Worth

3.3. Development of Formulas for Equivalence Calculation

4. Basic Methods of Engineering Economic Studies **7 hrs**

4.1. Minimum Attractive Rate of Return - MARR

4.2. Payback Period Method Simple and Discounted

4.3. Equivalent Worth Methods; Present Worth Method, Future Worth Method and Annual Worth Method

4.4. Rate of Return Methods: Internal Rate of Return (IRR) Method and External/Modified Rate of Return(ERR/MIRR) Method

4.5. Benefit Cost Ratio Method

5. Comparative Analysis of Alternatives **6 hrs**

5.1. Comparing Mutually Exclusive Alternatives having Same useful life by Payback Period Method, Equivalent Worth Method; Rate of Return Methods and Benefit Cost Ratio Method

5.2. Comparing Mutually Exclusive Alternatives having different useful lives by Repeatability Assumption, Co-terminated Assumption, Capitalized Worth Method

5.3. Comparing Mutually Exclusive, Contingent and Independent Projects in Combination.

6. Risk Analysis **4 hrs**

6.1. Origin/Sources of Project Risks.

6.2. Methods of Describing Project Risks; Sensitivity Analysis, Breakeven Analysis, Scenario Analysis

7. Ecological Limits and Economic Development **3 hrs**

7.1. Economic Theory and Ecological Limit,

7.2. Concept of sustainable development,

7.3. Ecological Footprint and

7.4. Overcoming Ecological Limits

8. Depreciation and Corporate Income Taxes **5 hrs**

8.1. Depreciation and its causes, Asset Depreciation and Accounting Depreciation

8.2. Basic Methods of Depreciation; Straight line method, Declining Balance Method, Sinking Fund Method, Sum of the Year Digit Method, Unit of Production Method, Modified Accelerated Cost Recovery System (MACRS)

8.3. Introduction to Corporate Income Tax. Taxation Law, Depreciation Rates Personal Tax, Corporate Tax, VAT

8.4. After Tax Cash flow Estimate, General Procedure for Making After Tax Economic Analysis

9. Enterprise Financing and Capital Investment **4 hrs**

9.1. Method of Financing: Equity Financing, Debt Financing and Capital Structure

9.2. Cost of Capital: Cost of Equity, Cost of Debt and calculating cost of capital

9.3. Project Funding Mechanism: Government budget, Public Private Partnership and Private Investment

9.4. FIRR, EIRR and Return on Equity

10. Basic Accounting Procedure **6 hrs**

10.1. Accounting Terminologies; Asset and liabilities: Fundamental equation of accounting

10.2. Financial statements: The Balance Sheet, Income Statement and Cash flow Statements

10.3. Using Ratios to make Decisions: Debt Ratio, Current Ratio, Quick Ratio – Acid Test Ratio, Inventory Turnover Ratio, Total Asset Turnover, Profit Margin on Sales, Return on Total Assets, Price Earnings Ratio and Book Value per Share

Tutorials:

Two assignments and 1 case study.

Text Book:

1. Chan S. Park. *Contemporary Engineering Economics.* PHI Learning Private Limited.

References:

1. E. Paul De Garmo, William G. Sullivan and James A. Bontadelli. *Engineering Economy.* MC Milan Publishing Company.
2. James L. Riggs, David D. Bedworth and Sabah U. Randhawa. *Engineering Economics.* Tata McGraw Hill Education Private Limited.
3. N.N. Borish and S. Kaplan. *Economic Analysis for Engineering and Managerial Decision Making.* MC Gran Hill Publishing Company.
4. Adhikari, D. *Principles of Engineering Economic Analysis.* Nepal: Global Publication.
5. Sen Gupta, Ramprasad. *Ecological Limits and Economic Development.* Oxford University Press.

CVL 431 Estimating and Valuation (3- 2 – 0)

Evaluation:

	Theory	Practical	Total
Sessional	50	-	50
Final	50	-	50
Total	100	-	100

Course Objectives:

The main objective of this course is to give the students, the knowledge of estimating, costing, valuation and specifications of civil engineering works. After completion of this course, students will be able to:

- calculate the quantities of different items of works of building structure and other civil engineering works,
- analyze the rates of various items of construction works,
- prepare valuation report of building structures,
- develop specifications of civil works, water supply and sanitary works and electrical works of building construction.

Course Contents:

1. Introduction and Methods of Estimating — 4 hrs

1.1 Introduction and Importance of estimation
1.2 System of Units
1.3 Units of Measurement and Payments for Items of Work and Materials
1.4 Requirements of Estimating
1.5 Methods of Measurements of Building and Civil Engineering Works
1.6 Subheads of Various Items of Work
1.7 Various Methods of Taking Out Quantities: Center Line Method, Long and Short Wall Method, Crossing Method
1.8 Abstracting Bills of Quantities

2. Types of Estimates — 4 hrs

2.1 Approximate Estimates
2.2 Detailed Estimates
2.3 Revised Estimates
2.4 Supplementary Estimates
2.5 Annual Repair and Maintenance Estimates
2.6 Extension and Improvement Estimates
2.7 Complete Estimates
2.8 Split up of Cost of Building Works

3. Analysis of Rates — 6 hrs

3.1 Introduction
3.2 Purposes of Rate Analysis
3.3 Importance of Rate Analysis

3.4 Cost of items, Transportation Cost, Other Expenses and Overhead, Contingency
3.5 Requirements of Rate analysis
3.6 Factor affecting the Rate Analysis
3.7 Procedure of Rate Analysis: For Building Works, For Sanitary and Water Supply Works, For Road Works, For Irrigation Works, For Suspension Bridge Works

16 hrs

4. Detailed Estimate

4.1 Estimate of Walls
4.2 Estimate for Single Room Building
4.3 Estimate for Two Room Building (Load Bearing structure)
4.4 Estimate of Framed structure Building
4.5 Estimate of an Aqueduct
4.6 Estimate of R.C.C. Slab Culvert
4.7 Estimate of R.C.C T-Beam Decking
4.8 Estimate of Septic Tank and Soak Pit
4.9 Mode of measurements based on codes (NBC and Indian codes)
4.10 Estimate of Earthwork by Three Methods
4.11 Estimate of Earth work of Hill road

5 hrs

5. Valuation

5.1 Introduction
5.2 Purpose of Valuation
5.3 Terms Used in Valuation
5.4 Methods of Determining Value of Property
5.5 Methods of Valuation Report Writing

10 hrs

6. Specification

6.1 Introduction
6.2 Necessity of Specification
6.3 Types of Specification: General and Detailed Specification
6.4 Specification writing Technique
6.5 Specification writing: Civil works, Water supply and Sanitary works and Electrical works

Tutorials:

1. Estimate for a single Room Building (Load Bearing Wall and Frame Structure)
2. Estimate for a two room building (load bearing wall and frame structure)
3. Estimate of earth work by three method.
4. Estimate of hill road.
5. Estimate of an aqueduct
6. Estimate of RCC slab culvert
7. Estimate of RCC T-beam decking
8. Estimate of Septic Tank and Soak Pit.
9. Valuation Report writing
10. Specification writing of civil works, Water supply and Sanitary works and Electrical works of building construction.

Textbook:

Chakraborti, M. (1986). *Estimating, Costing, Specification and Valuation in Civil Engineering.*

References:

1. Aggarwal, Amarjit (1985). *Civil Estimating Quantity Surveying and Valuation.* Ludhiana: Katson Publishing House.
2. Dutta, B.N. *Estimating and Costing in Civil Engineering.* Delhi: USB Publishers distributers Ltd.
3. Berger, Seymour & Godel, Jules B. (1977). *Estimating Project Management for Small Construction Firms.* New York: Van Nostrand Reinhold Publishing Company.
4. Upadhya, A. K. *Civil Estimating & Costing Valuation Engineering.*
5. Patil, B.S. *Contract and Estimation.*
6. Norms and Rate analysis of GoN
7. Standard Specification of GoN.

WRE 430 Hydropower Engineering (3-2-1)

Evaluation:

	Theory	Practical + Field Report	Total
Sessional:	30	20	50
Final:	50	-	50
Total:	80	20	100

Course Objective:

After completing this course, the student will be able to:

- describe the hydropower development and opportunities in Nepal,
- take part in study, selection and planning of hydropower projects,
- design head-works, water-conveyance structures, spillways and energy dissipaters of hydropower plant and
- select and describe different electro-mechanical and hydro-mechanical components of hydropower plant.

Course Contents:

1. Introduction to Hydropower Development **2 hrs**

1.1 Sources of energy and importance of hydropower.
1.2 Hydropower development in Nepal: historical background, present development, challenges and opportunities.
1.3 Hydropower potential in Nepal: gross, technical and economic potential.
1.4 Introduction to some large hydropower plants in the world.
1.5 A brief introduction to government policy and major institutions related to hydropower development in Nepal: hydropower development policy, ministry of energy, WECS, electricity tariff fixation commission, DoED, Nepal electricity authority, IPPAN and NMHDA (private sector).

2. Planning and Investigation of Hydropower Projects **6 hrs**

2.1 Hydropower project planning stages: reconnaissance, pre-feasibility & feasibility studies.
2.2 Hydrological data processing: mass curve and flow duration curve (Weibull method), their characteristics and its uses in hydropower planning.
2.3 Reservoir planning and regulations: classification, site selection, need of reservoir regulation, life of reservoirs.
2.4 Environmental study policy based on type & size (IEE/EIA).
2.5 Climate change and ecology: river engineering, social costs, population displacement, change in lifestyle, global worry, clean energy alternatives

3. Power and Energy Potential Study **4 hrs**

3.1 Gross, net, operating and design head.
3.2 Plant and installed capacity.
3.3 Energy flow diagram (related to FDC), firm & secondary power and energy.

3.4 Economic consideration in HP system: marginal cost-benefit approach and introduction to optimization approach.
3.5 Estimation of power and energy potential and its demand prediction methods.
3.6 Load curve (mean and peak load), load factor, utilization and diversity factors.
3.7 Power demand variation: daily, weekly, monthly and annual variations of power.
3.8 Power grid: introduction and components of power grid system.

Storage Type of Hydropower Projects **7 hrs**

4.1 General layout of components in a typical storage power plant: dam body, spillway, bottom outlets or under sluices, intakes with examples.
4.2 Dams and their appurtenant works:
- 4.2.1 Classification based on function, material, head and mode of structural load transfer.
- 4.2.2 Forces acting on dams and their combination.
- 4.2.3 Site selection for dams and selection of type of dam.
- 4.2.4 Principal variant of embankment and concrete dams.
- 4.2.5 Failure modes of Embankment and concrete dams and their prevention measures; foundation treatment, grouting and their necessity.
- 4.2.6 Design of gravity (concrete) dams: general considerations, cross-sectional profiles, stability analysis (safety factor against overturning, sliding), stress and material failure (crushing), limiting height of concrete dam.
- 4.2.7 Design of earthen (embankment) dams: general considerations, safety against slope stability, phreatic line, seepage flow discharge, drainage.

4.3 Intakes: general arrangement and types of dam intakes, location, function, hydraulic consideration in intakes.
4.4 Gates: types and their location in dam.
4.5 Reservoir sedimentation issues and sedimentation management in brief.

Run-of-River types of Hydropower Projects **6 hrs**

5.1 General layout of components in a typical power plant: dam body, weir, spillway, under sluices and intakes with examples.
5.2 Different types of intakes, importance, location and types, design concept of intake structure, head loss calculation in intake structure (trash rack losses).
5.3 Performance standards of headworks: control of bed load and floating debris in intakes, himalayan intake and hydraulic design of gravel trap.
5.4 Sediment handling measures: types, location & design criteria of settling basin, its design and estimation of sediment volume.
5.5 Flushing of settling basin: flushing frequency (periodical and continuous).

Water Conveyance Structures **6 hrs**

6.1 Introduction to power canal, its suitability in hydropower project.
6.2 Hydraulic tunnels: definition, geometrical shape, pressure and non-pressure tunnels, rock stress, hardness coefficient of rocks, hydraulic design of tunnel (velocity and sizing), introduction to tunneling methods, supports in tunnel, tunnel lining, steps of tunneling procedure.

6.3 Forebay and surge tank: importance, location, condition of application and hydraulic design of forebay structure; different types of surge tank and hydraulic design a surge tank (height & cross-sectional area).

6.4 Penstock and pressure shaft: importance, location, condition of their application, water hammer, water hammer pressure computation by RWCT & EWCT, wall thickness of penstock /pressure shaft (steel), economic diameter of penstock (optimization study in brief).

6.5 Headloss calculation in conveyance system.

5 hrs

7. Spillways and Energy Dissipaters

7.1 Spillway: definition, purpose, types, design specifics (Ogee shape), cavitations and prevention measures.

7.2 Method of energy dissipation below the dam structure: types of energy dissipaters (ski-jump, flip bucket, stilling basin) and their necessity, natural type of energy dissipater, role of tailwater depth.

7.3 Design of stilling basin.

5 hrs

8. Hydro-mechanical & Electro-mechanical Equipments

8.1 Hydro-mechanical installation in powerhouse:

8.1.1 Types of turbines: Pelton, Francis, Kaplan turbines and their performance characteristics, introduction to Bulb turbine.

8.1.2 Specific speed, synchronous speed and runaway speed.

8.1.3 Selection of turbines.

8.1.4 Design of Francis and Pelton turbines.

8.1.5 Scroll case, draft tube and tailrace canal and their importance.

8.2 Electro-mechanical installation:

8.2.1 Introduction to generator and their types.

8.2.2 Working principle of governors in Pelton and Francis turbines.

8.3 Pumps:

8.3.1 Introduction to centrifugal and reciprocating pumps.

2 hr

9. Powerhouse Planning

9.1 Classification, general arrangement and layout plan of powerhouse.

9.2 General dimension calculation of powerhouse.

2 hr

10. Micro Hydropower Plant

10.1 Introduction, scope and applications.

10.2 Introduction to policy of MHP development in Nepal.

10.3 Advantages and relevance of MHP in Nepal.

10.4 General Layout of basic components of MHP.

Laboratories:

1. Performance characteristics of a Pelton/Francis/Kaplan turbine.
2. Working principle and characteristics of centrifugal/reciprocating pump.

Field Observation:

One observation tour of a hydropower plant in the vicinity and each student should prepare a brief report in prescribed format on the basis of their field visit.

Text Books:

1. Dandekar, M. M. and Sharma, K. N. (2010). *Water Power Engineering*. New Delhi: Vikas Publishing House Ltd.
2. Garg, S. K. (2007). *Hydrology and Water Resources Engineering*. New Delhi: Khanna Publishers.
3. Novak, P., Moffat, A. I. B., Nalluri, C. & Narayan, R. (2007). *Hydraulic Structures*. London: Taylor & Francis.

References:

1. Baral, S. (2013). *Text book of Hydropower Engineering*. Kathmandu: Engineering and Education Services Pvt. Ltd.
2. Varshney, R. S. (2001). *Hydro Power Structures*. India: New Chand & Bros.
3. Mosonyi, E. (1965). *Water Power Development Vol.2 High Head Power Plants, Mitget Stations and Pumped Structure Schemes*. Budapest: Akademiai, Kiado Publishing House of the Hungerian Academy of Sciences.
4. Layman's (1998). *Guidebook OnHow To Develop A Small Hydro Site*. European Small Hydropower Association (ESHA).
5. DoED, MoWR (2006). *Design Guidelines for Headworks of Hydropower Projects*.

TRP 411 Transportation Engineering I (3-2-2)

Evaluation:

	Theory	Practical	Total
Sessional	30	20	50
Final	50	-	50
Total	80	20	100

Course Objectives:

After successful completion of this course, the students will be able to:

- understand the basic concepts on the highway planning and survey,
- design geometric elements and drainage system for highways,
- design specific highway elements for roads in hilly areas and
- select the suitable material for highway construction.

Course Contents:

1. Introduction to Transportation Planning and Engineering **4 hrs**

1.1 Introduction
1.2 Modes of Transportation
1.3 Comparison between various Modes of Transportation
1.4 Historical Development of Roads: Roman, Tresaguet, Telford, Macadam
1.5 Road Construction in Nepal
1.6 Transport Planning including Objectives of Road Planning
1.7 Classification of Roads: Strategic Road Network, Rural/Local Road Network, Urban Road

2. Highway Alignment and Engineering Survey **4 hrs**

2.1 Highway Alignment
  2.1.1 Introduction
  2.1.2 Requirements of Highway Alignment
  2.1.3 Factors Controlling Highway Alignment
2.2 Engineering Survey and its Stages
  2.2.1 Route Location Process
  2.2.2 Engineering Survey: Map Study, Reconnaissance, Preliminary and Detailed Survey

3. Geometric Design of Highway **18 hrs**

3.1 Definition and Scope of Geometric Design
3.2 Introduction to Road Standards in Nepal (Strategic Roads, Local Roads and Urban Roads)
3.3 Design Controls and Criteria
3.4 Elements of Cross-section: Urban roads, Rural roads
3.5 Elements of Horizontal Alignment
  3.5.1 Definition and Types of Horizontal Curve
  3.5.2 Design of Horizontal Curve including Night Visibility Consideration

3.5.3 Sight Distance: Stopping Sight Distance, Overtaking Sight Distance, Set-back from Obstructions
3.5.4 Super-elevation
3.5.5 Extra-widening
3.5.6 Transition Curve: Definition and types of Transition Curve, Design of Transition Curve

3.6 Elements of Vertical Alignment
3.6.1 Definition and Types of Gradient
3.6.2 Grade Compensation
3.6.3 Definition and Types of Vertical Curve
3.6.4 Design of Vertical Summit Curve
3.6.5 Design of Vertical Valley Curve

4. Highway Drainage 4 hrs

4.1 Introduction and Importance of Highway Drainage System
4.2 Causes of Moisture Variation in Sub-grade Soil
4.3 Surface Drainage System
4.3.1 Different Types of Road Side Drain
4.3.2 Cross Drainage Structures (Culverts and others)
4.3.3 Different Types of Energy Dissipating Structures
4.4 Sub-surface Drainage System
4.4.1 Drainage of Infiltrated Water
4.4.2 Control of Seepage Flow
4.4.3 Lowering of Water Table
4.4.4 Control of Capillary Rise

5. Hill Road 5 hrs

5.1 Introduction
5.2 Special Considerations in Hill Road Design
5.2.1 Alignment of Hill Road Design: General Consideration, Route Location in Hills, Gradient, Design and Types of Hair Pin Bends
5.2.2 Types of Cross Sections
5.3 Special Structures in Hill Road
5.3.1 Types of Retaining Structures
5.3.2 River Training Structures
5.3.3 Slope Stabilization Structures and Gully Control Structures
5.3.4 Road Safety Measures in Hill Roads: Barriers and Delineation

6. Highway Materials 10 hrs

6.1 Introduction and Classification of Highway Materials
6.2 Sub-grade Soil
6.2.1 Characteristics of Sub-grade Soil
6.2.2 Desirable Properties of Sub-grade Soil
6.2.3 California Bearing Ratio Test
6.3 Road Aggregates
6.3.1 Definition and Classification of Road Aggregates

6.3.2 Desirable Properties of Road Aggregates
6.3.3 Tests on Road Aggregates and their Significance
6.3.4 Comparing Gradation Specification
6.3.5 Proportioning of the Road Aggregates
6.4 Bituminous Road Binders
6.4.1 Definition and Classification of Road Binders
6.4.2 Liquid Bitumen: Cut-back Bitumen and Bitumen Emulsion
6.5 Tests on Bituminous Binders: Penetration, Viscosity, Ductility, Softening point
6.6 Bituminous Mixes
6.6.1 Definition and Classification
6.6.2 Marshal Method of Bitumen Mix Design

Laboratories:

1. Tests on aggregates: Crushing Value and Impact Value
2. California Bearing Ratio Test
3. Tests on Bitumen: Penetration Value, Viscosity, Softening Point and Ductility
4. Asphalt Mix Design: Marshall Stability Test
5. Extraction of Bitumen from Mix

References:

1. Sharma, S.K. *Principles, Practice and Design of Highway Engineering.* New Delhi: S. Chand and Co. Publishers Ltd.
2. Khanna, S.K. & Justo, C.E.G. Highway Engineering. Roorkee (U.P.): Nem Chand & Bros.
3. Flaherty, C.A. Highway Engineering. Edward Arnold (Publishers) Ltd.
4. Kadiyali, L.R. An Introduction to Highway Engineering. Delhi: Khanna Publishers.
5. Relevant Publications by Department of Roads and Department of Local Infrastructure Development and Agricultural Roads (DOLIDAR).