NRI INSTITUTE OF INFORMATION SCIENCE & TECHNOLOGY BHOPAL

DEPARTMENT OF CIVIL ENGINEERING

LAB MANUAL

STRENGTH OF MATERIALS LAB

NIIST BHOPAL		NRI INSTITUTE OF INFORMATION SCIENCE & TECHNOLOGY DEPARTMENT : CIVIL ENGINEERING LIST OF EXPERIMENTS	FORM NO	NIIST/A/10
BRANCH	CIVIL		REV. NO	0
SEMESTER	V		REV. DT	30/06/2011

SUBJECT /CODE :QSC LAB /CE505

SNO	LIST OF EXPERIMENTS
1	Preparation of detailed estimate.
2	Detailed estimate for services of plumbing and water supply or Electrification work.
3	Detailed estimate for earth work for the road construction or arched culvert.
4	Rate analysis for at least 8 items of construction.
5	Preparation of DPR of Civil Engineering Project.

QUANTITY SURVEYING & COSTING LAB

LO	LAB OUTCOMES
LO1	Preparation of detailed estimation can be done
LO2	Estimation of plumbing work and electrification work can be analyzed
LO3	Earth work can be estimated by calculations
LO4	Rate analysis can be done
LO5	DPR case study can be prepared after the lab

Table of Contents

1. SALIENT FEATURES

1.	Title of the project	
2.	District	
	Thaluk	
	Corporation/Municipality/Panchayath	
	Assembly Constituency	
3.	Implementing agency/SPV	
4.	DPR prepared by	
5.	Project outlay	
6.	Budget provision	
7.	Budget speech reference	
8.	Administrative sanction	
9.	Nature of the project (New bridge/ROB/ reconstruction of existing bridge/strengthening of existing bridge/ widening and strengthening of existing bridge)	
10.	Present status of existing bridges/roads	
11.	Need for the project	
12.	Type of bridge	
	Total span length of bridge	
	Overall and carriage way widths	
	Provision of footpath	
	IRC loading class	
	Other details of proposed bridge	
13	Length of approach roads	
	Other details of approach roads	
14.	Details of investigations/surveys conducted	
	i. Topographical	
	ii. Hydraulic	
	iii. Geotechnical	
	iv. Traffic	
	v. Others	
15.	Whether land accusation involved?	
	If yes, furnish details	
16.	Total estimated cost and item wise cost	

	break up and details of Schedule of Rates	
	Whether detailed estimate attached?	
17.	Details of revenue streams	
18.	Details of Cost Benefit Analysis (CBR value)	
19.	Details of project risks	
20.	Details of project management organisation strategy	
21.	Details of contract management strategy	
22.	Details of Project Implementation Schedule (PIS) & Work Breakdown Schedule(WBS) - Proposed duration to complete the project	
23.	Details of statutory clearances	
24.	Quality Control infrastructure and Mechanism	
25.	Operations & Maintenance(O&M) arrangements of the project after Completion	
26.	Details of attached drawings	
27.	Other attachments	

2. EXECUTIVE SUMMARY:

This section shall contain brief of all relevant details discussed in the following chapters.

3. CHAPTERS:

3.1.INTRODUCTION

This section should provide a general introduction of the project being submitted and shall include write up on: type of the bridge project, location of the project area, general description of topography, physiography and geology of the project area, historical background of the project, need for the project, etc

3.1.1.Project Definition, Concept and Scope

The proposed project has to be clearly demarcated in terms of all its sub-components/elements including quantum of land required, whether any acquisition is needed, the design, detailed engineering and drawings of each physical infrastructure sub components, environmental compliance,/protection measures/improvement measures .

3.1.2. Project background

A brief description of the existing bridge, if any, in the project area, its present condition and need for the present project.

3.1.3.Project Details

a. Description of the location and geographic features of the area and adjoining land.

b. A brief description of the geometry of the approach roads, description of whether there are temples, schools, mosques along the alignment, existing cross drainage structures, existing utilities like electric & telephone poles and water lines along the proposed bridge.

3.1.4. Objective and scope of the work

A brief note about the necessity of the works proposed under the project and the main works to be carried out to fulfill the objective.

3.2. STATUS FEASIBILITY STUDIES

- Description of any feasibility study conducted earlier and their outcome shall be discussed in this section.

3.3. REQUIREMENT/ DEMAND ANALYSIS

This section should contain:

- the specific problem(s) or issue(s) faced by stakeholders like citizens, businesses or governments that would be addressed by means of provision of improved services through the proposed project.
- describe the project proposed in terms of the rationale behind the project, clearly focusing on the existing condition (how it will help in improving the situation and bring benefits to the stakeholders).
- The rationale could be broad based and supplemented with facts and figures. Information based on objective research, not subjective impressions, should be provided to justify the need or problem. The rationale should be written in a way that would lead to objectives.

3.4. ENGINEERING SURVEYS AND INVESTIGATIONS

This section should contain:

1.Topographic Survey/leveling survey with GPS stations and coordinates – incorporating the methods used and satisfying all standards and procedures.

2. Leveling Survey with GPS stations and coordinates, a brief methodology of leveling survey, accuracy adopted, nearest bench mark etc.

3.Soil and Materials Survey :

i.. Soil investigation report including CBR details

ii.. Borrow area and quarry details ensuring the quality and quantity of materials, construction water sources

iii.. Soil sample collection and Testing

4. Traffic Survey

3.5. FUNCTIONAL DESIGN

- This section should present an analysis of different options available to achieve the objective and the reasons for selecting the proposed option should be substantiated.
- The functional design of the project is mainly achieved through field study and documentation using existing information and specifications from various standards
- The location shall generally be governed by the approach that minimum shifting will be required for improvements of geometrics, unless there are special bridge design problems. The requirement of the most suitable site shall have overriding consideration and the site so selected shall regulate the approach alignments.
- The alignment shall be fixed with a view to serve maximum population and to achieve the maximum utility of the existing road system, if any. The alignment shall preferably be one which demands minimum land acquisition, minimum span length and filling height of approaches, economic structural elements etc.
- History of hydraulic functioning of existing/nearby bridge, if any, under flood, general direction of river course through the structure, afflux, extent and magnitude of flood, aggradation / degradation of the bed, evidence of scour, damage to structure and adjacent property, maintenance problems and records of any other bridges across the same river in the vicinity etc. shall be considered.
- The number of supports and their locations shall be fixed as to provide the most economical design of the bridge and at the same time satisfy special requirements, if any, for navigation, railways or other crossings in consultation with the concerned authorities, floating logs or debris and bridge aesthetics, etc.

- The span arrangement of the bridge shall be considered as one which results in minimum construction cost with respect to the actual site conditions like width of river, hydraulic parameters, geotechnical aspects etc.
- The field study shall also include traffic surveys and documentation which may be done as per the latest revisions and amendments of the relevant guidelines of MoRTH, publications of Indian Roads Congress (IRC) and Bureau of Indian Standards (BIS).

3.6. ENGINEERING DESIGN

- This section should elaborate the technology choices, structural aspects, substructure options and evaluation of the technology option, as well as the basis for the technology for the proposed project.
- The design should cover proposed alignment plan, longitudinal profile, cross section details, location map, index map, proposed culvert drawings, strip plan
- Detailed description of site including hydraulic and geotechnical investigations adequate to design the suitable foundation and substructure shall be furnished.
- The type of the bridge shall be so selected that the viability of adopting state of the art super structures like continuous span bridge, integral bridge, long span arch bridge, balanced cantilever bridge etc. shall be explored with a view to bring in aesthetics as well as economy.
- The selection between RCC and PSC structural systems shall be judiciously made depending upon the span arrangement and economic considerations.
- The preliminary design for a typical bridge project shall consist of alignment, complete GAD with all relevant details including that of approaches, extend of flexible pavement, rigid pavement, etc. conforming to the guidelines laid down in the latest revisions and amendments of IRC, MoRTH and BIS.

3.7. FINANCIAL ESTIMATES & COST PROJECTIONS

- This section should focus on the cost estimates, budget for the project, means of financing and phasing of expenditure.
- Cost estimates have to be worked out on the basis of detailed bill of quantities (with detailed measurements of length, breadth, and depth / height for each item), using

the current Schedule of Rates of the State Government (PRICE) or relevant SOR as applicable.

- Applicable taxes, contingencies, investigation charges including any O&M cost for a specific period shall be clearly specified.
- Lump sum provisions for land acquisition etc. shall be explained in detail.

3.8. REVENUE STREAMS

- Options for cost recovery, if any, should be explored
- Innovative ideas for additional revenue generation including advertisements, parking facilities below the deck etc, may be indicated.

3.9. COST BENEFIT ANALYSIS& INVESTMENT CRITERIA

- Cost Benefit Analysis (CBA) is a technique whereby the costs of and benefits from a scheme are quantified over a selected time horizon and evaluated by a common yardstick.
- In bridge project appraisal, it is important first to study the present traffic flow pattern, comprising of: 1) service across the river by a small ferry, carrying passengers and light vehicles, and/or 2) detouring of vehicles by alternate route, generally over long distance.
- This will be followed by forecast of average daily traffic over the proposed bridge for the time horizon of the study. This will represent the normal traffic growth and the volume generated by the proposed bridge.
- Cost Benefit Ratio (CBR - benefit to cost ratio), EIRR (Economic Internal Rate of Return) etc. shall be worked out in detail with all supporting primary and secondary data conforming to the guidelines of IRC: SP 30 - 2009.
- The project cash flow projections for the life cycle along with underlying assumptions have to be presented.

3.10. ENVIRONMENTAL & SUSTAINABILITY ASPECTS

- An Environmental Management Plan (EMP) is to be developed explaining the possible environmental issues which may arise during the construction and operation of the infrastructure and associated facilities depending upon the size of the project.

- Environmental impact assessment study if mandatory and measures identified to mitigate the adverse impact, if any shall be conducted and documented in detail.
- Issues relating to land acquisition, diversion of forest land, wildlife clearances, rehabilitation and resettlement should be addressed in this section.
- Inclusion of international best practices in sustainable infrastructure management including potential low carbon, low energy, zero pollution etc. is desirable.

3.11. RISK ASSESSMENT AND MITIGATION MEASURES

- For those projects which involve large capital outlay and various issues relating to land acquisition, environmental aspects, a detailed and systematic risk analysis may be resorted.
- Identification and assessment of implementations risks which can lead to time overrun, cost escalation, scope reduction etc. is the primary stage in risk assessment.
- Risk analysis could include legal/contractual risks, environmental risks, revenue risks, project management risks, regulatory risks etc.
- The mitigation plans including risk avoidance, risk transfer, and risk elimination are to be well analyzed and documented.
- For complex projects with multiple risk profiles, numerical modeling and simulation may be adopted..

3.12. PROJECT MANAGEMENT ORGANISATION

- Responsibilities of different agencies for project management of the said project should be elaborated. The organization structure at various levels, human resource requirements, as well as monitoring arrangements should be clearly spelt out.
- Management arrangements refer to the institutional structures and mechanisms that would be set up for ensuring effective project management.
- The involvement of external consultant if any shall be documented

3.13. CONTRACT MANAGEMENT STRATEGY

- Contracting methodology for the execution of the project should be specified in detail. (item rate, lumpsum, design and execute , EPC etc.)
- The system followed in the bidding document and manuals of reference etc. shall be explained (PWD/CPWD/ FIDIC) etc.

- Any variation proposed from the current practices acceptable under Government of Kerala (Arbitration, escalation etc.) in the system due to any specific technical aspects associated with the project need to be explained with justification.
- Any contract clause which may likely to lead to additional financial liability shall be identified and reported with suggestions to overcome such issues.

3.14. IMPLEMENTATION SCHEDULE & WBS

- The time bound work schedule is an important part of every project because it helps in better handling of projects in planning, implementation etc.
- This section should indicate the proposed zero date of commencement and also provide a Bar chart / Project Schedule, wherever relevant.
- Phasing of project activities, proposed contract packages and schedule of implementation for each phase.
- Identify critical dependencies in the project and expected timelines for completion of key milestones and associated process indicators for the same.
- The DPR should provide a time-bound action plan including tendering, appointment of contractors, construction schedule,, quality assurance & quality control and post-construction activities, including project delivery

3.15. STATUTORY CLEARANCES

- This section should elaborate the statutory clearances to be obtained from the various authorities.
- Statutory approvals as per bye laws, master plan, fire safety norms, environmental clearance etc. as applicable for the project are to be taken.

3.16. QUALITY MANAGEMENT PLAN

- The DPR shall include information relating to the institution to be engaged in the quality assurance & quality control of the project execution.
- Methodology to be adopted to ensure the quality of construction should be clearly mentioned in the report.
- Quality management plan including the internal inspection and testing procedure shall be documented.

- Third party quality control mechanism is adopted its structure and plan shall be specified in detail.

3.17. OPERATIONS & MAINTENANCE PLAN

- The DPR shall incorporate/include information relating to the institution to be engaged in the O&M of the created infrastructure asset/enhanced infrastructure assets.
- Brief description/analysis of the key issues and obstacles in regard to O&M (including billing/collection issues) and proposed countermeasures to overcome them for the project should be contained.
- Requirement of funds for operation and maintenance of assets should also be included in the report.

ANNEXURES

I. KEY MAP OF THE PROJECT LOCATION
II. APPROVED ALIGNMENT DRAWING
III. GENERAL ARRANGEMENT DRAWING
IV. DETAILED ESTIMATE
V. GEO-TECHNICAL INVESTIGATION REPORT
VI. HYDRAULIC INVESTIGATION REPORT
VII. COPIES OF STATUTORY APPROVALS

EXPERIMENT NO. 1

Aim: Preparation of detailed estimate of building (using long wall and short wall method).

Requirement: given plan and section of building, find out the length of long wall and length of short wall , etc.

Procedure:

1. Longer walls in a building are considered as long walls and measured from out to out.
2. Shorter walls in a building are considered as short wall and measured from in to in.
3. These lengths of long wall and short wall are multiplied separately by the breath and height of the corresponding layer and added to get quantity and it changes according to area.
4. Find length of long and short wall.
5. First calculate centre to centre lengths individually from the plan.

Calculation:

1. Length of long wall=parallel to x-axis=(c/c distance +width of Item).
2. Length of short wall=parallel to y-axis=(c/c distance-width of item).

Precaution:

1. All units of item of works are correct.
2. Calculation should be done carefully.

Result: Total quantity of all item of work is.....

EXPERIMENT NO. 2

Aim: preparation of detailed estimate of building (using center line method).

Requirement: given plan and section of building, find out the length of long wall and length of short wall, etc.

Procedure:

1. In this method total length of wall is equal to sum of length of long wall and length of short wall.
2. These total length of walls are multiplied by the breath and height of the corresponding layer and added to get quantity.

Calculation:

Total centre Length of walls = centre length of long wall + centre length of short wall.

Precaution:

3. All units of item of works are correct.
4. Calculation should be done carefully.

Result: Total quantity of all item of work is.....

EXPERIMENT NO. 3

Aim : analysis of rate (for concrete work).

Requirement: given the grade of concrete, rate of cement, rate of sand , rate of course aggregate, rate of labor ,etc.

Procedure:

1. Find out the quantity of cement.
2. Find out the quantity of sand.
3. Find out the quantity of course aggregate.
4. Find total rate.

Calculation and formula:

1. 1bag cement=0.0345m3 =50kg=34.5liters.
2. 1 m3 of wet concrete=1.54 m3 of dry concrete.
3. Total rate =rate of material +rate of labor.

Precaution:

1. All units of item of works are correct.
2. Calculation should be done carefully.

Result: Total rate of concrete work is.....

EXPERIMENT NO. 4

Aim : Analysis of rate (for brick work).

Requirement: given the size of bricks , rate of cement ,rate of sand,, rate of labor rate of brick ,etc.

Procedure:

1. Find out the quantity of cement.
2. Find out the quantity of sand.
3. Find total no. of bricks used.
4. Find total rate.

Calculation and formula:

1. 1bag cement=0.0345m3 =50kg=34.5liters.
2. vol. of 1 brick with mortar (nominal size) =200mm*100mm*100mm.
3. vol. of 1 brick without mortar (actual size) =190mm*90mm*90mm.
4. Total rate =rate of material +rate of labor.

Precaution:

1. All units of item of works are correct.
2. Calculation should be done carefully.

Result: Total rate of bricks work is.....

EXPERIMENT NO. 5

Aim : analysis of rate (for plaster work).

Requirement: given the size of bricks , rate of cement ,rate of sand,, rate of labor ,etc.

Procedure:

1. Find out the quantity of cement.
2. Find out the quantity of sand.
3. Find total no. of bricks used.
4. Find total rate .

Calculation and formula:

1.1bag cement=0.0345m3 =50kg=34.5liters.
2. vol. of 1 brick with mortar (nominal size) =200mm*100mm*100mm.
3. vol. of 1 brick without mortar (actual size) =190mm*90mm*90mm.
4. Total rate =rate of material +rate of labor.

Precaution:

1. All units of item of works are correct.
2. Calculation should be done carefully.

Result: Total rate of bricks work is.....

EXPERIMENT NO. 6

Aim : Estimation of quantity of reinforcement(for beam) .

Requirement: given the details of reinforcement (for column ,beam ,slab ,etc.).

Procedure:

1. Find out the quantity of bent up bars.
2. Find out the quantity of stirrups.
3. Find out the quantity of hanger/top bars.
4. Find total quantity and rate.

Calculation and formula:

1. Length of straight bar=overall spans +length of hooks.
2. Hook length (for one end) =9*dia. of bar.
3. Hook length (for both end) =18*dia. of bar.
4. Total rate =rate of material + rate of labor.

Calculation table:

SN.	DESCRIPTION NO.	LENGTH (m)	BREAT(m)	HEIGHT(m)	QUANTITY(kg)

Precaution:

1. All units of item of works are correct.
2. Calculation should be done carefully.

Result: Total rate of steels work is.....

EXPERIMENT NO. 7

Aim : preparation of approximate estimate for road project.

Requirement: given the details of road work (like GL, natural surface level, gradient, side slopes, change of level, etc.)

Procedure:

1. Find out the cutting area.
2. Find out the filling area.
3. Find out the volume of cutting.
4. Find out the volume of filling.
5. Find out the total volume of cutting and filling.

Calculation table:

SN.	ROAD DISTANCE(M)	CUT AREA (M2)	MEAN AREA(M2)	LENGTH(M)	CUTTING VOLUME(M3)

Formula used:

1. Area = (p/4)*d
2. Area of trapezoidal section = (b+b

Precaution:

1. All units of item of works are correct.
2. Calculation should be done carefully.

Result: Total rate of road work is.....

EXPERIMENT NO. 8

Aim : Estimating cost of building on plinth area method.

Requirement: given the details of building works and there rates.

Procedure:

1. Find out the total area of building (including walls ,verandah ,corridors ,etc.)
2. Find out the total area and cost.
3. Find out other costs (water supply ,electricity ,special services).
4. Find grand total.

Calculation and formula:

1. Total area/plinth area=carpet area +corridor +stair +walls +etc.

Calculation table:

SN.	DESCRIPTION NO.	LENGTH(m)	BREATH(m)	HEIGHT(m)	QUANTITY(kg)

Precaution:

1. All units of item of works are correct.
2. Calculation should be done carefully.

Result: Total cost of building is.....