CHAPTER IV
PRESENTATION AND IMPLEMENTATION OF DEVELOPED CURRICULUM

4.0 Introduction

The present chapter informs about the presentation and implementation of the (PBL) Project based learning-based Internship program for third year undergraduate civil engineering students. This chapter describes the details of implementation of the PBL based internship program. The methodology of the research study was presented in previous chapter III.

4.1 Planning and Development of PBL based Internship Program

The PBL with approach of internship program was planned to conduct with third year civil engineering students. As per AICTE's curriculum most of the professional civil engineering core courses were learned by the undergraduate program students by the end of sixth semester. This PBL based internship program was implemented after the students had appeared for the sixth semester exams and had the availability to attend the offered PBL based Internship program. In the conducted internship program thirty-three undergraduate students had participated and which were divided equally into different teams. A group leader was assigned from each group and researcher assured that work had been distributed evenly among all the team members. All members were given work responsibilities like writing down notes, discussion of queries with site supervisors, taking pictures, reviewing design plans, equipment specifications, material grading, safety procedures, understanding the transition from design plans to the field work during conducting the assigned field practicum along with preparing daily and final group reports and presentations. The objective of planning PBL with approach of internship program is to incorporate an element for startling clarity, vision of the academic information in professional careers of undergraduate civil engineering students. Internship is

a temporary–work placement or field training opportunity to learn work and experience field practicum.

Project-based learning is an appropriate paradigm for addressing design and construction project management problems. As the technical expertise is required for building projects, it is integral for students to go through a practicum environment to understand the different aspects of a civil engineering and construction projects in the work environment. The role of instructor comes as facilitator who drafts, implements PBL based program instructions and encourage students on identifying problems, doing discussions, finding solutions, making reports, and presenting the respective subject matter. PBL is the learning approach which teaches strategies and skills to face challenges in today's global technically advanced world. The close coordination between academia and industry would result in a fruitful progress. The internship, industry or field programs allow the students for:

- Observance of work hours, the importance of punctuality virtue of the individuals and its implementation in an organization.
- Observance of time management skills as preparing and submitting the reports or logbooks on scheduled time and meeting deadlines of projects.
- Enhancing self-presentation skills which includes appropriate expression, presentation, oral and written communication, and self-confidence.
- Experiencing and understanding the mission, vision, values, and goals of work organizations.
- Identifying their own strengths, weaknesses and the areas which needs improvement when exposed to the outside working world.
- Observance of job responsibilities carried by professionals at different levels while working in the organization.
- Self-evaluation of the technical competence or field knowledge of subject matter while by observing and participating in the field practicum and an opportunity to explore and learn the latest development techniques.
- Lifelong learning skills like problem solving, decision making, communication and teamwork.

4.2 PBL based Internship program's curriculum development

The PBL based internship program's curriculum was developed for following sections of civil engineering. These sections of civil and construction engineering were included to impart students to gain complex and multifaceted content of a subject matter by relating it with realistic world problems.

The following were the offered sections of PBL based internship program's curriculum for conducting field practicums.

- Site Survey and Ground Investigation
- Construction Site Excavation Practicum
- Soil Testing Reports, Foundation Design, Coordination of construction plans
- RCC Foundation Construction
- Building Construction Practicum
- Precast Structures
- Construction Management and administrative practices

The PBL based internship program was conducted for total of three weeks, Monday through Saturday from 9 am to 1pm for the assigned project practicum group activities as per developed PBL based internship program curriculum.

4.3 Presentation and Implementation pattern of developed PBL based internship curriculum’s project practicums.

1. **PBL based internship program's curriculum section.**

I. Sub sections of PBL based internship program's curriculum.

II. Learning objectives for each section of PBL based internship program's curriculum.

III. Time assigned to conduct the daily assigned group project practicums of PBL based internship program's curriculum.

2. **Field Practicums for section of PBL based internship program’s curriculum.**

I. Theory relating to PBL based internship program's group practicums.

II. Implementation details of PBL based internship program's project practicums.

I. Theory relating to PBL based internship program's group practicum.

- Theory topics to review as per assigned group practicums of PBL based internship program’s curriculum section.
- Researcher provided background theory and lesson plans to be reviewed by students as per PBL based internship program's assigned practicums.

II. Implementation details of PBL based internship program's project practicums.

- Method of learning and approach
- PBL based internship program practicums as assigned for group of students.
- Assessment for PBL based internship program's conducted group
- practicums
- Learning outcomes of implemented PBL based internship program's conducted assigned project practicums.
- Pictures of the PBL based internship program’s conducted group practicum.
- Researcher's observations

Table 4.1

Representation of implementation pattern of developed project practicums of present study.

<table>
<tr><td colspan="2">Presentation and implementation pattern of developed PBL based internship curriculum’s project practicums.</td></tr>
<tr><td colspan="2">1. PBL based Internship program's section information</td></tr>
<tr><td colspan="2">I. Sub sections of PBL based internship program's curriculum.
II. Learning objectives for each section of PBL based internship program's curriculum.
III. Time assigned to conduct the daily assigned group project practicums of PBL based internship program's curriculum.</td></tr>
<tr><td colspan="2">2. Field Practicums for section of PBL based internship program's curriculum.</td></tr>
<tr><td colspan="2">I. Theory relating to PBL based internship program's group practicums.
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• PBL based internship program practicums as assigned for group of students.

• Assessment for PBL based internship program's conducted group practicums

• Learning outcomes of the implemented PBL based internship program's conducted assigned project practicums for group of students.

• Pictures of the PBL based internship program’s conducted group practicum.

• Researcher's observations.</td></tr>
</table>

Table 4.2

Detailed schedule of conducted field practicum with groups (1,2,3,4)

Field Practicum	**Days (5 hours/day) on the construction site for field practicum**																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Pretest Site Orientation	All																
Site plan Ground Investigation		All															
Soil Testing Concrete Testing										All							
Construction Site Excavation			1	1	4	2	3	3	4		2						
Foundation Drawings Construction			3	3	1	1	2	4	2		4						
RMC and Quality Control			4	2	3				1								
Building Construction			2	4	2	4	1	1	3		3						
Construction Management						3	4	2			1						
Precast Plant												All					
Expert lecture													All				
Site review														All			
Post Test															All		
Project Report Presentation, Feedback																All	
Internship Completion Certificate																	All

4.3.1 Presentation and implementation pattern of developed PBL based internship curriculum's project practicums.

4.3.1.1 Construction site survey and orientation

Introduction and orientation with/at PBL based internship site and site supervisors.

- Group of students introduced themselves and get familiarized with internship site, construction manager, project engineer and site supervisors. Students discussed and planned in their specific groups as how to proceed and share responsibilities and work as team members with the daily PBL based internship program assigned project practicum. Mandatory safety procedures were discussed with the students for their safety at the construction site.

4.3.1.2 Site survey and ground investigation

4.3.1.2.1 PBL based Internship program's Site Survey and Ground Investigation

Information

I. Sub sections

1. Onsite existing physical features on site and adjacent property
2. Benchmark elevations and site dimensions
3. Physical properties of soil and landscape conditions.
4. Terrain, grading and drainage patterns
5. Underground utilities.

III. Learning objectives for students for Site Survey and Ground Investigation

- Students will be able to prepare sketch of existing/proposed site including existing buildings, structures and of adjacent properties.
- Students will be able to depict the correct aspect of site by marking position of trees, shrubs, boundary walls, fences, gates, existing vehicular and pedestrian access, and adjoining footpath.
- Students will be able identify the terrain and levels of the site. Check surrounding areas datum or existing benchmark for reference elevation point.
- Students will be able to visualize grading and drainage patterns of the site.

- Students will be able to identify general characteristic of landscape and physical characteristics of top and sub soil.
- Students will be able to research and sketch about the existing water table level, gas and electricity lines, municipal water supply lines, storm drainpipes, sewer lines, manholes and inlets.

IV. Time assigned to conduct the daily assigned group project practicums of Site Survey and Ground Investigation.

- On site project work: 5 hours for the field practicum
- Offsite theory review and daily report: 4 hours for reviewing project related to onsite/field practicum and putting together daily report for conducted field practicum.

4.3.1.2.2 Field Practicums for Site Survey and Ground Investigation

I. Theory relating to PBL based internship group practicums

- Theory topics to review as per assigned group practicum of Site Survey and Ground Investigation

➢ Group of students researched the site location by Google maps
➢ Reviewed topography surveying theory for onsite project activity.
➢ Group of students reviewed the instructions (copy attached) provided for Site topography survey checklist to explore and prepare for PBL based internship group project practicum.
➢ Group of students reviewed the example of site plan showing topographic survey and ground investigation field notes to conduct the related PBL based internship group project practicum.

- **Researcher provided background theory and lesson plans to be reviewed by students as per PBL based internship program's assigned practicums.**

Site surveys are studies in detail done to verify site information and include:

➢ Existing buildings including valuation, measured and structural surveys.
➢ Structural investigations
➢ Geological and geotechnical
➢ Topographical surveys
➢ Local climate
➢ Flood risk.

- Air quality
- Historic use
- Boundary and structural surveys
- Railway and tunnel search
- Fire hydrants
- Telecommunications
- Wireless networks and satellite reception
- Electrical utilities and capacity
- Gas utilities and capacity
- Sewers and Storm drains
- Existing water supply

Soil Investigation

Soil is the natural resource and there are adverse effects on soil when land is considered for development purposes like Civil engineering practicum. The detail study of the site topographical as well as physical and chemical characteristics of soil is called soil survey. Soil surveys provide us the appropriate use of land and development options. It provides us the detail information to find out the type of topsoil and sub soils on the site. The soil survey was done by doing sampling on trial pits with sampling equipment such as hand Auger samples were taken on repeated basis to differentiate out the possibilities of different soil characteristics such as PH, particle size, organic matter for the collected samples.

A soil survey report includes:

- Characteristics of soil.
- Different types of Soils on the site.
- Location of different types of soil types.
- Recommendation of potential use of soil.

Site investigation happens in different stages:

- Planning, Research, Investigation and Study: It sets clarity for objective to do site investigation, enable to carry out the historical, geological and environmental information for the site. Identify the potential characteristics of the soil. Main investigation was done through sampling and testing to identify different soil parameters of the soil samples.

Ground investigation:

- It is the way to determine the ground conditions and utilities information required for appropriate, efficient implementation of design of proposed construction work. The underground utilities can be identified with the proper investigation of underground obstruction, groundwater, presence of faults and conditions of the ground.

Ground investigations can help determine:

- Water table level and water flow.
- Thicknesses of ground layer and properties of soil.
- Information about the underground utilities.

Site Plan - Example

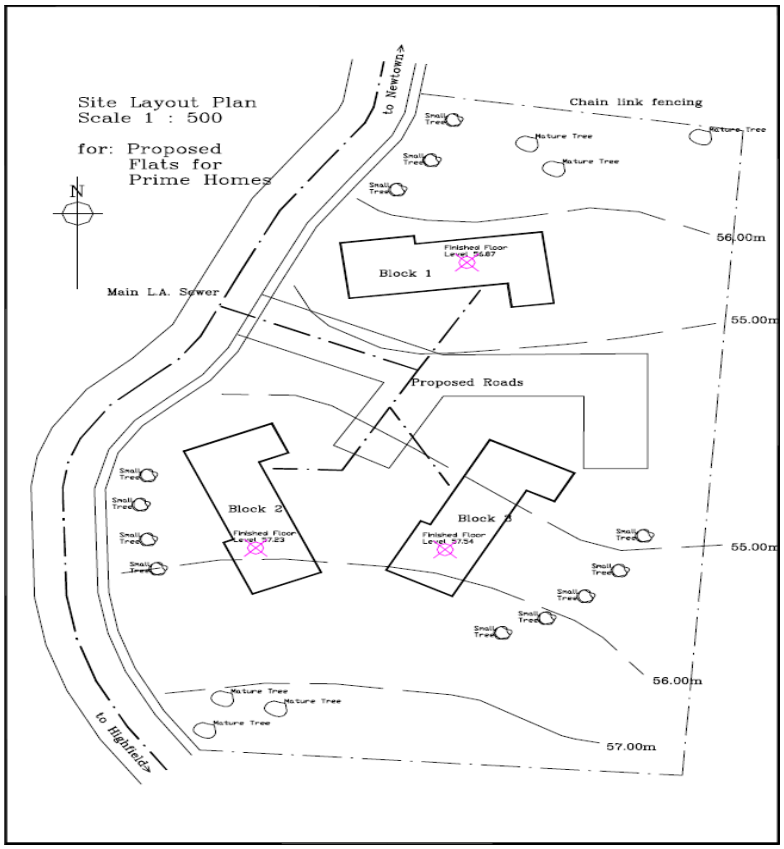


Figure Source - Wikipedia. Picture 4.1

A site plan is a scaled drawing of the existing and proposed development. The scales and the detail of information of the project may vary as per project area limits but the drawings will include the same details for different sites.

- Title block, project name, drawing type, author, scale.

- Directional orientation - North-pointing arrow.
- Overall Dimensions
- Site boundaries, adjacent properties, and surrounding streets.
- Existing buildings and their utilities
- Existing vegetation
- Dimensions and locations of existing Parking areas, traffic flows.
- Roads, footpaths, ramps, paved areas and so on.
- Buildings to be demolished or removed.
- Underground and surface utilities
- Lights, electric poles.
- Gates, Walls, and Fence

Instructions for Onsite utility practicum worksheet and site plan.

General particulars of Proposed Construction Site Survey and Ground Investigation:

- Client's name, address, and telephone number.
- Address of property to be surveyed.
- Date of survey.
- Existing buildings
- Details of adjacent properties and roads.
- Adjacent properties of owners
- Position of trees and shrubs.
- Details of existing vehicular and pedestrian access adjoining footpath
- Particulars of boundary walls, fences and gates.
- Physical properties of the soil.
- Water table and liability to flooding.
- Details of any existing structure and materials of the existing buildings.
- Services like gas and electricity on plan the position of the mains and meters
- Water main location if possible.
- Storm and Surface water drainage.
- Sewer Information
- Existing heating and ventilation systems

Site Plan Particulars:

- North Arrow (on all plans)

- Graphic Scale (1mm=100 cms)
- Site boundary survey and topography.
- Date and source of survey, topography benchmark reference, boundary
- description, adjacent property owners.
- Include all streets with names, widths, and location.
- Label all existing structures and their use.
- Locate all utilities (on site plan) and provide the names of the utility providers.
- Label about entrance dimensions
- Locate all the existing septic/sewer systems.

Onsite Project Work activity for Site Survey Checklist:

Location

Title of Project

Date

Water Company Source

- Quantity Pressure
- Location -
- Quality:
- Drinking Testing

Electricity

- Company Source
- Volts Phase
- Cycle KW
- Location

Communications

- Telephone
- Company Source

Perimeter Fences

- Temporary Permanent
- Type and ± lineal meters required:

Tie-Ins

- Process Piping: Company Others

Site Conditions

- Clear Brush Trees Other

Underground

- Water table meters below grade
- Possibility of unknown obstructions:
- Yes No
- Abandoned footings
- Sewers
- Above Ground

Obstructions to movement of construction or plant equipment:

- Yes No
- Type Location
- Pipe ways
- Structures
- Power Lines

Terrain

- Level _____ Slope _____ Rough
- Soil Characteristics
- Rock Sand Clay

Weather

- Temperature
- Winter Summer
- Prevailing Wind
- Direction: Average Velocity:
- Precipitation Rain Rainy season, Windstorms.)
- Yearly Average / Centimeters, Record Centimeters

II. Implementation details of PBL based internship section site survey and ground investigation project practicums.

- **Method of learning:** Project Based Learning
- **Approach:** Problem solving through Project based learning practicum for outside classroom learning.
- **PBL based internship program's assigned practicums for students**

Day 1 PBL field practicum 1: 3 hours

Site survey, sketching Site plan

- PBL based internship Group Project activity for conducting a topographic survey and sketching a site plan by locating the physical features, landscape and vegetation patterns, electric lines, adjacent street information and other particulars of site topography as per provided checklist was performed by the students.

Day 1 PBL field practicum 2: 2 hours

Ground Investigation

- PBL based internship group project practicums was conducted for ground investigation by researching and collecting the information about existing underground utilities, water table level, sub soil profile, flood liability and other legal documents for provided activity work sheet.

- **Assessment for PBL based internship group practicums**

- Daily and Weekly reports: summarizing the field work practicum for day and week.
- Post-test and discussion were conducted at the end of the PBL based internship program.
- Final report and presentation included the field knowledge and experience attained by conducting topic related PBL based internship group practicum.

- **Learning outcomes of the implemented site survey and ground investigation group practicums**

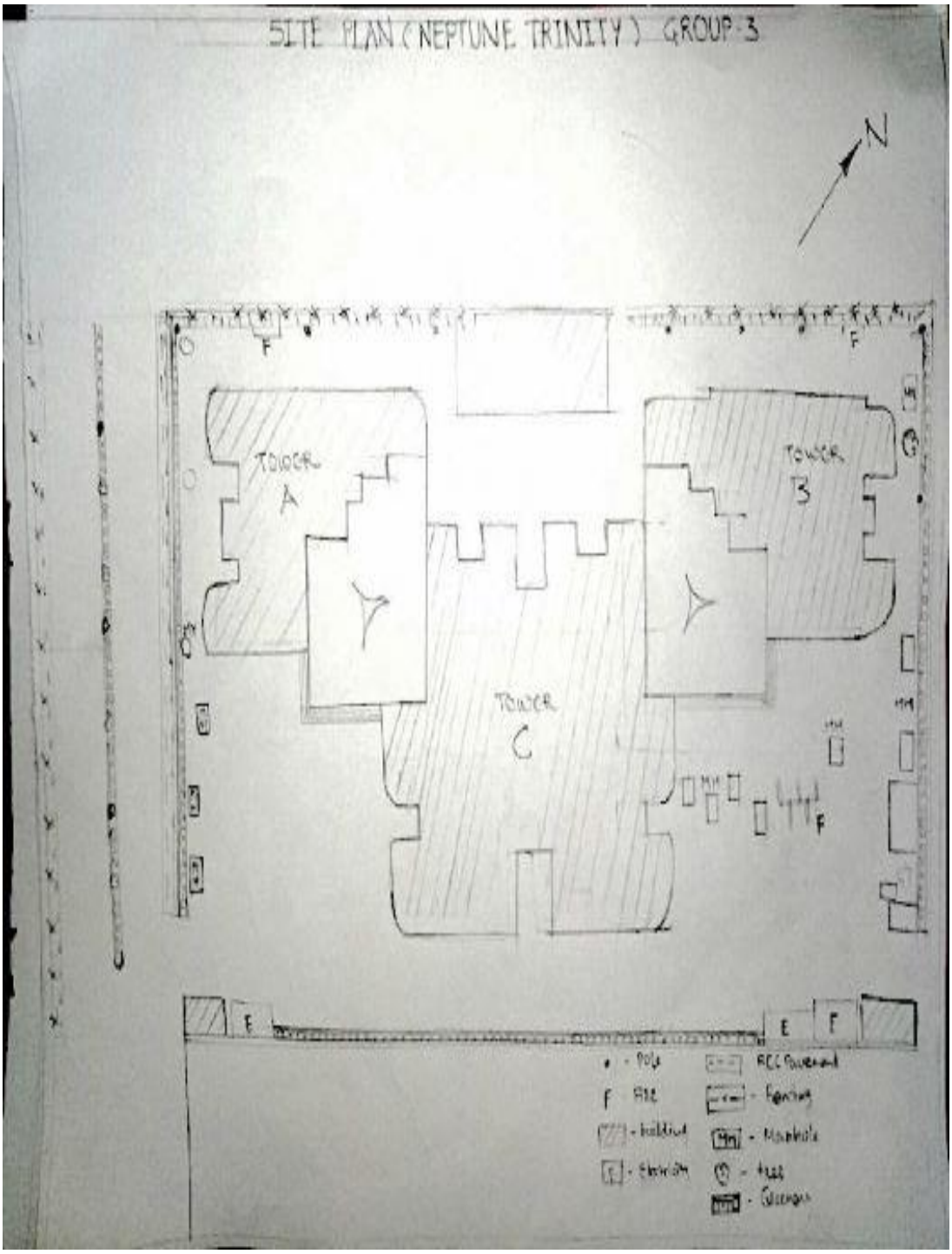
- Students can prepare site plan of proposed site by including existing buildings, structures and of adjacent properties.
- Students can sketch the position of trees, shrubs, boundary walls, fences, gates, existing vehicular and pedestrian access and adjoining footpath on site plan.
- Students can identify the terrain of the site by comparing against surrounding areas datum or existing benchmark for reference elevation point.
- Students can visualize and depict existing grading and drainage patterns of the site.

- Students can identify existing landscape and physical characteristics of top and sub layer of soil.
- Students can research and sketch about the existing water table level, gas and electricity lines, municipal water supply lines, storm drainpipes, sewer lines, manholes and inlets.

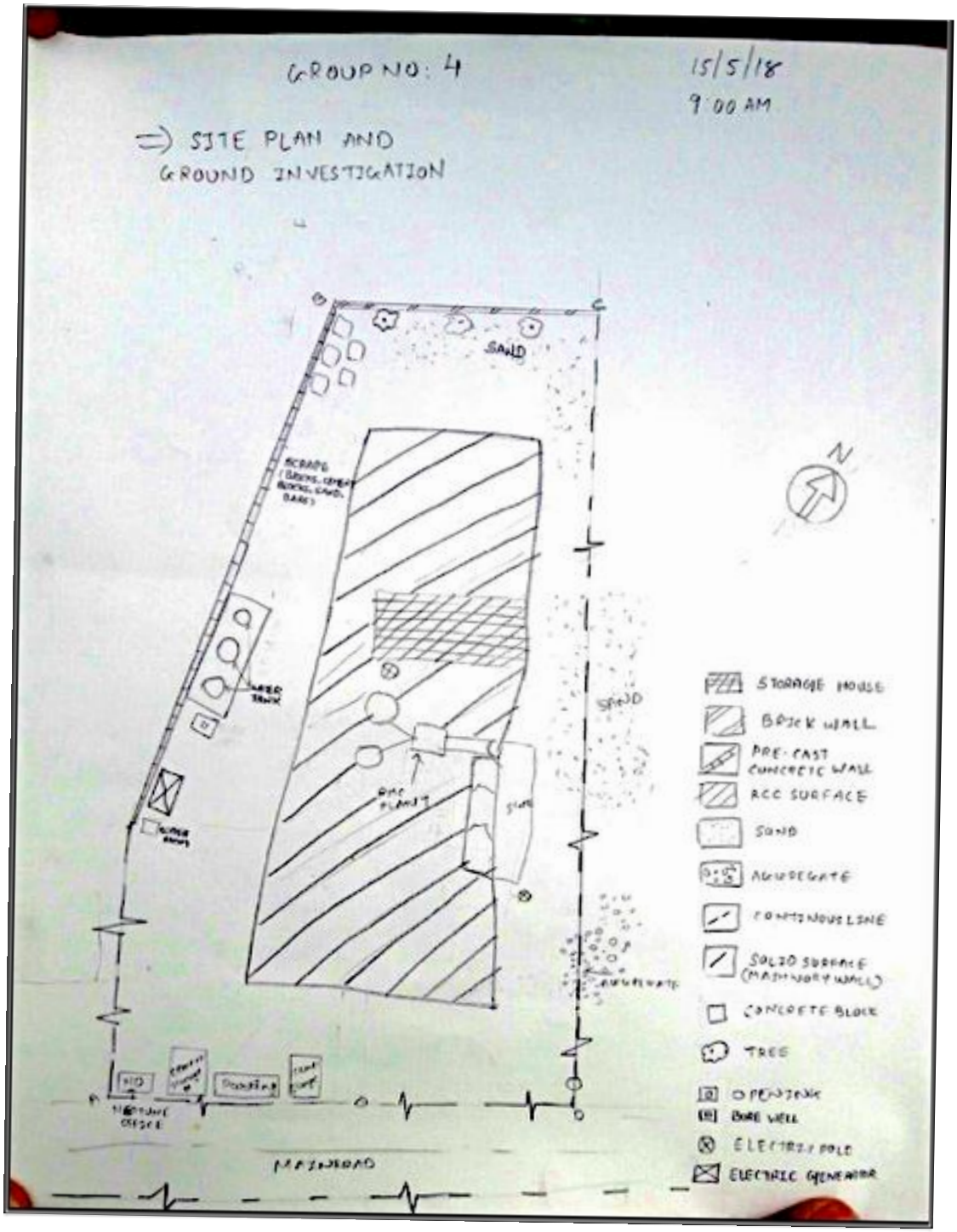
- **Pictures of the PBL based internship program's implemented group practicum**
- Site Plan and Ground Investigation

Picture 4.2 Students taking measurements and investigating on existing utilities

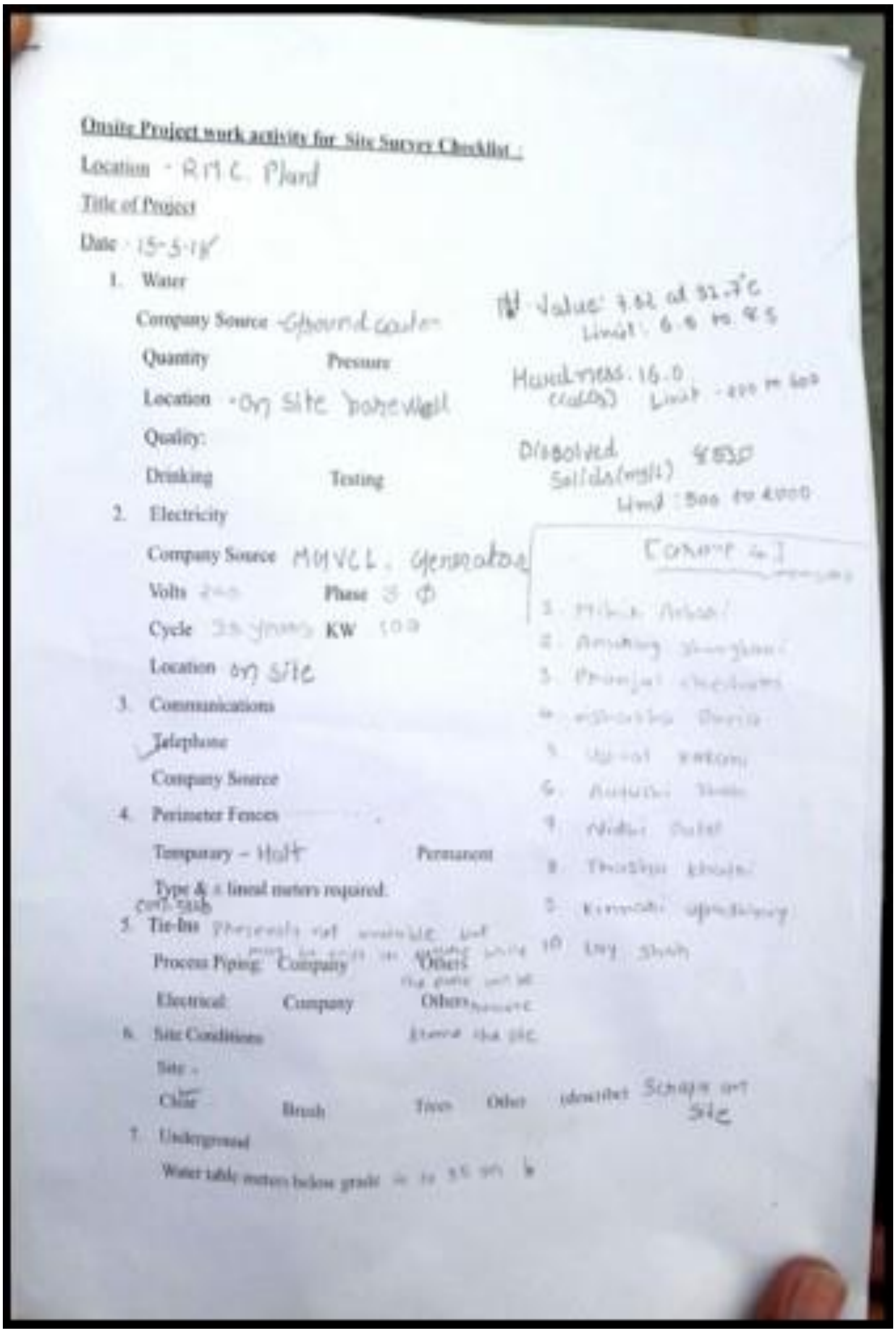
Picture 4.3 Students taking measurements and investigating on existing utilities



Picture 4.4 Typical Site Plan drawing by students.



Picture 4.5 Typical Site Plan Drawing by students.



Onsite Project work activity for Site Survey Checklist :

Location - RMC Plant

Title of Project

Date - 15-5-18

1. Water

Company Source - Ground water

Quantity Pressure

Location - On site borewell

Quality:

Drinking Testing

2. Electricity

Company Source MGVCL, Generator

Volts Phase 3 Φ

Cycle KW

Location on site

3. Communications

Telephone

Company Source

4. Perimeter Fences

Temporary - Halt Permanent

Type & ± lineal meters required:

5. Tie-Ins

Process Piping: Company Others

Electrical: Company Others

6. Site Conditions

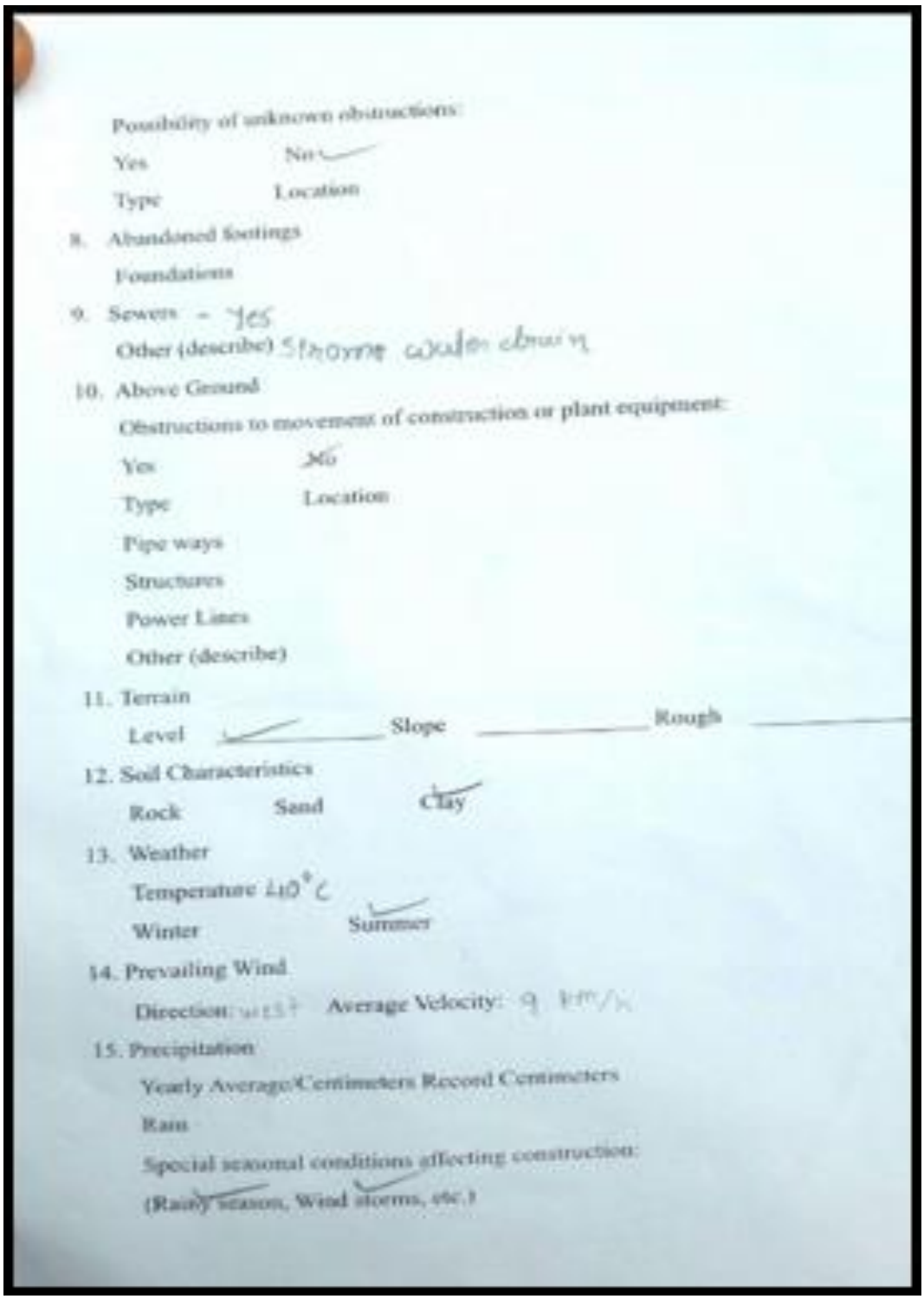
Site -

Clear Brush Trees Other (describe) Scraps on Site

7. Underground

Water table meters below grade

Picture 4.6 Students working for ground investigation worksheet per assigned project practicums.



Possibility of unknown obstructions:

Yes No

Type Location

8. Abandoned footings

Foundations

9. Sewers - Yes

Other (describe) Storm water drain

10. Above Ground

Obstructions to movement of construction or plant equipment:

Yes No

Type Location

Pipe ways

Structures

Power Lines

Other (describe)

11. Terrain

Level Slope Rough

12. Soil Characteristics

Rock Sand Clay

13. Weather

Temperature 40°C

Winter Summer

14. Prevailing Wind

Direction: West Average Velocity: 9 km/h

15. Precipitation

Yearly Average/Centimeters Record Centimeters

Rain

Special seasonal conditions affecting construction:

(Rainy season, Wind storms, etc.)

Picture 4.7 Students working for ground investigation worksheet per assigned project practicums.

- **Researcher's observations of students while conducting project practicums of site survey and ground investigation**

➢ Researcher had observed the significant improvement in the students' use of appropriate technical terminology and identifying the details of construction activities from the site orientation day (beginning) to last phase (end) of PBL based Internship Program.

➢ Students had shown great enthusiasm, cooperativeness while measuring and investigating on existing site utilities for site plan and ground investigation Practicum.

➢ Researcher discussed with all the groups before and after the field practicum about the distribution of responsibilities and fair share of work shared by all the team members and observed that students carried the assigned responsibilities very well.

4.3.1.3 Construction site excavation

4.3.1.3.1 PBL based Internship program's construction site excavation information

I. Sub sections

1. Excavation practicum
2. Safety regulations on excavation site
3. Excavation equipment required and its efficiency
4. Measuring earthwork

II Learning Objectives:

- Students will be able to locate, monitor and study how excavation site work as per approved site plans under the supervision of site supervisor.
- Students will be able to identify need for the type of excavation equipment required and its efficiency for site practicum.
- Students will be able to identify need of safety regulations on excavation site
- Students will be able to measure site earthwork (cut or fill) per code IS 1200 under the supervision of the Site Supervisor.

III. Time assigned to conduct the daily assigned group project practicums of construction site Excavation.

- On site project work: 8 hours for the field activity. 4-5 hours for 2 days.
- Offsite theory review, daily report: 6 hours for reviewing project theory related to onsite/field practicum and putting together daily report.

4.3.1.3.2 Field practicums for construction site excavation.

I. Theory relating to PBL based Internship program's group practicums

- **Review of theory topics as per assigned group practicums of Construction site excavation**

➢ Group of students reviewed the safety regulations for Site Excavation work.

➢ Group of students reviewed and studied the need and type of excavation equipment required.

➢ Group of students referred the IS 1200 and IS 3385 for mode of earthwork measurement.

- **Researcher provided background theory and lesson plans to be reviewed by students as per PBL based internship program's assigned practicums.**

➢ **Excavation**

➢ Excavation is the process of moving of the required earth, rock or any other materials with excavation tools, equipment and with the help of the explosives in the field. Some of other applications are exploration of area, environmental restoration. Mining and construction earthwork, trenching, wall shafts, tunneling and underground utilities excavation are other aspects of excavation.

- **Types of Excavation:**
- Several types of excavation are classified by the specific purpose, or the type of work or material excavated. Some of the types of excavation depends on type and material for excavated.

➢ Bridge excavation-materials which impede the construction of foundations, substructures to support are needed to be removed or excavated during the construction of bridge.

➢ Borrow - Soil or gravel take from a pit are to be excavated and are used in another location for other purposes.

➢ Channel - It is the type of excavation from ditches and drainage patterns for drainage system.

- Drainage ditches - are excavated to prevent from damage to habitation, infrastructure, agriculture by funneled water away from it.
- Dredge - underwater excavation in rivers or shallow ocean passages for the purpose of removing sediment to other locations so that boat traffic can navigate.
- Earth - excavation removal for engineering purposes on removing existing or laying a structure foundation, digging a drainage ditch.
- Footing - precise excavation for construction of footings and gave a point where excavation can begin.
- Muck. - Undesirable muck, soil and water are removed out for soil to get dry.
- Roadway - Slope and other embankments are earthed and the excavated materials can be used for building of the roadway.
- Rock - is quite challenging as rocky surfaces which impede the construction or engineering projects were removed for proposed construction and sometimes used for other purposes but requires special equipment for excavation.
- Underground - such excavation required different tools, equipment, and techniques to remove materials safely and effectively as it underground and it may damage the existing structures

Hazards of Excavation:

Hazards involving excavations can lead to serious incidents involving workers at construction sites.

The major hazard is the Cave-ins at excavation site.

The injuries or deaths can happen during cave-ins. Workers working in excavation can be trapped in cave-ins if occur on even small jobs of underground utilities for example working on water, gas, electrical and sewer line connections.

Some of the other hazards are:

- Falling into the trenches or excavations.
- Debris, spills and tripping over equipment.
- Falling of excavated material or other objects on workers.
- Exposure to underground services or overhead electrical cables.

- Adjacent structures instability.
- Poorly placed or mishandled materials.
- Noxious gases, lack of oxygen and hazardous atmosphere
- Explosive, toxic, and irritating gases.
- Plan before you dig:
- Clear area and remove debris near excavation site
- Information about the soil type
- Excavation safety measures
- Removing muck and water in excavation
- Identify and locate overhead power lines and underground services
- Notification requirements safety and emergency exit plan
- Coordination of workers working underground and on surface

- **Precautions:**

- Determine how workers will enter and exit excavation
- Coordination between excavation equipment and tools
- Possibility of environmental hazards, rain during excavation
- Vibrations caused by mobile equipment may affect existing structures.
- Training to workers

- **General duties of workplace parties:**
- **Some examples of Supervisor duties:**

  - Instruction and supervision to workers to protect themselves
  - Ensure the competence of equipment operators and signalers
  - Reasonable precaution in the circumstances for the protection.
  - Safety measures and procedures are carried out in the workplace
  - Regulations for equipment, materials and protective devices as required

- **Some examples of workers' duties:**

- To wear appropriate personal protective equipment
- To use or operate equipment in a safe manner
- To report any defects in equipment to your supervisor or employer

Types of Excavation equipment:

1. Excavators

Excavators are large construction equipment that can be available over wheels

tracks. An excavator is traditional type and usually has a long bucket arm attached to pivoting cab that can rotate a full 360 degrees.

Picture 4.8 Types of Excavator Source: Pixabay, thebalancemb

The most common uses of an excavator are:

- Handling of material
- Excavation of trenches, holes, and foundations
- Brush cutting with hydraulic attachments
- Demolition work
- Rough Grading of site
- Pipe Installation
- Excavation for Mining
- Dredging of river

2. Backhoe Loaders

Backhoe loaders are quite similar equipment to tractors. Backhoe loaders can adjust and shovel in front of the equipment with a small bucket in the back of the loader which can be used for digging purposes. Backhoe loaders are medium sized construction equipment for smaller jobs and are limited to perform the small operations. They can help move the dirt, do backfills, dig trenches, and can place smaller pipes into place.

Picture 4.9 Backhoe loader excavator Source: Pixabay, thebalancemb

3. Bulldozers

Picture 4.10 Bulldozer excavator Source: Pixabay, thebalancemb.

In construction industry, one of the strongest considered and most reliable equipment are the Bulldozers. It is quite powerful and can manage extremely heavy equipment which is used to move dirt for large open tracts of land. The utility of the equipment includes in pushing piles of earth for rough/fine grading.

4. Motor Graders

Picture 4.11. Motor Grader excavator Source: Pixabay, thebalancemb

To grade and move small amounts of dirt, motor graders are used as the heavy equipment. To create the flat surface and the long blades are adjusted to meet certain angles.

5. Crawler Loaders

Picture 4.12 Crawler Loaders excavator Source: Pixabay, thebalancemb.

Crawler loaders can increase your production during hauling material off or on-site. Because too their property of track mountain, their movement is flexible without the need of additional transportation. Utility of an equipment can be to load spoils into trucks and dump soil in various locations.

6. Scrapers

Picture 4.13 Scraper's excavator Source: Pixabay, thebalancemb.

A scraper can move dirt and aggregates within the site easily and without the needs of additional equipment.

7. Common Dump Trucks: Dump trucks are needed on every site There are multiple sizes and variations to move your load easily and effectively. Off-road or regular dump trucks, they are used in all construction projects.

II. Implementation details of PBL based internship section construction site excavation project practicums.

- **Method of learning:** Project Based Learning
- **Approach:** Problem solving through Project based practicum for outside classroom learning.
- **PBL based internship program's assigned practicums for students**

Day 1 Activity 1: 2 hours and 30 minutes

Review site plan, locate excavation areas and identify type of equipment needed.

- Group of students reviewed the site plan with site supervisor and locate the excavation areas on the construction site. Students inquired and discussed for the type of equipment needed for efficient site excavation practicum. Students examined which factors control the choice of excavation equipment and activity.

Day 1 Activity 2: 2 hours

Monitoring excavation practicum and identifying safety regulations.

- Student groups monitored the site excavation practicum and understood the flow of work per site plan drawings as an onsite Project activity under the supervision of site supervisor. Students identified the safety regulations and appropriate safety measures to be taken accordingly during site excavation work during discussions with site supervisor.

Day 2 Activity 2: 2 hours 30 minutes

Earthwork measurements.

- Project activity for group of students was to understand the mode and conduct the site earthwork measurements and calculations per IS 1200 and IS 3385 codes under the supervision of site supervisor. Students identified the cut and fill earthwork quantities and areas according to the grading and drainage patterns of site plan.

- **Assessment for PBL based internship group practicums**

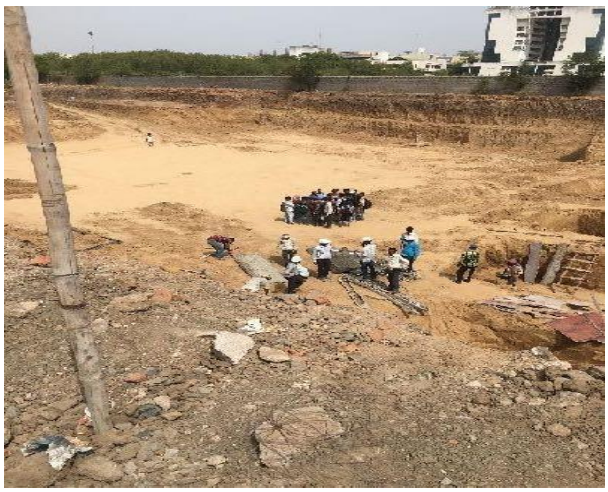
- Daily and Weekly reports: Summarizing the field work practicum for day and week.
- Post-test and discussion were conducted at the end of the PBL-internship program.
- Final report and presentation included the field knowledge and experience attained by conducting topic related PBL-internship group practicum.

- **Learning outcomes of the implemented PBL based internship program's group practicums.**

- Students can locate and identify and monitor the excavation areas on construction site per site plan under the supervision of site supervisor
- Students can identify the different types of excavation equipment required for site excavation practicum.
- Students can identify general safety measures required for site excavation work.
- Students can conduct the earthwork measurements as per code IS 1200 under the supervision of site supervisor

- **Pictures of the PBL based internship program's implemented group practicum.**

- Construction Site Excavation Practicum



Picture 4.14 Students interacting with team members and site supervisors for excavation field practicum

Picture 4.15 Students interacting with team members and site supervisors for excavation field practicum

Picture 4.16 Students interacting in a group as team members and ensuring and monitoring excavation field practicum under the supervision of site supervisors.

Picture 4.17 Students interacting in a group as team members and monitoring excavation field practicum under the supervision of site supervisors.

Picture 4.18 Students interacting in a group as team members and monitoring excavation field practicum under the supervision of site supervisors.

Picture 4.19 Students interacting in a group as team members and monitoring excavation field practicum under the supervision of site supervisors.

- **Researcher's observations of students while conducting project practicums for construction site excavation:**

➢ The interest, involvement, and motivation to conduct field practicum was very high among the students despite hot weather and harsh construction site conditions.

➢ Students had worked and assist the field supervisors for unexpected situations in excavation and foundation construction which enhances their learning in tackling such situations and developing problem solving skills.

➢ Students followed construction site safety regulations quite well and were responsible to collect and submitted back the provided safety equipment daily

4.3.1.4 Soil testing and foundation design

4.3.1.4.1 PBL based Internship program's Soil testing and foundation design information

I. Sub sections

1. Soil Testing Procedure
2. Analyzing Soil Testing Report
3. Foundation design method as per soil’s load bearing capacity.

4. Construction Foundation design drawings
5. Coordinate and manage construction practicum as per construction design drawings.

II. Learning Objectives

- Students will be able to analyze soil testing procedures.
- Students will be able analyze the soil testing report and role it plays in design of foundations.
- Students will be able to analyze the foundation design procedures based on site's soil bearing capacity.
- Students will be able to identify the foundation design drawings in reference to theoretical foundation design by having discussions with the design and site engineers.
- Students will be able to relate different construction drawings with project construction practicum while having discussions with the Design and Site engineers.

II. Time assigned to conduct the daily assigned group project practicums of PBL based internship program's curriculum

- On Site project work: 8 hours for the field activity. 4 hours for3 days.
- Off Site theory review and daily report: 6 hours for reviewing project theory related to onsite/field practicum and putting together daily report.

4.3.1.4.2 Field practicums for soil testing and foundation design

I. Theory relating to PBL based internship program's group practicum.

- **Theory topics to review as per assigned group practicums of Soil Testing and Foundation Design**

➢ Group of students reviewed the soil testing procedures to calculate load bearing capacity of soil.

➢ Group of students reviewed the procedure for theoretical design of RCC reinforced cement concrete foundations as per NBC - National Building Code standards.

➢ Group of students reviewed and studied the role of soil's load bearing capacity in design of RCC foundations.

➢ Group of students reviewed the method to draw the RCC foundation construction drawings per theoretical design

- Group of students referred SP-34 handbook on concrete reinforcement and detailing.

- **Researcher provided background theory and lesson plans to be reviewed by students as per PBL based internship program's assigned practicums.**

- Types of Soil Tests for Building Construction
- Types of Soil tests needed for the construction projects depend on physical and chemical properties of the existing or native soil. Design of foundation is based on soil test report of construction site. Different soil tests for construction of buildings or any structure is the beginning in the process of construction planning to understand about the suitability of soil for proposed Project.
- Various tests on soil are conducted to decide the quality of soil for building construction. Some tests are conducted in laboratory, and some are in the field.
- Moisture content test
- Atterberg limits tests
- Specific gravity of soil
- Dry density of soil
- Compaction test (Proctor's test)

(Please refer the Geotechnical engineering book for details to perform these tests)

- **Bearing capacity of Soil:**

- The bearing capacity of soil is defined as the capacity of the soil to bear the loads coming from the foundation. Bearing capacity is the ability of a soil to support a load from foundation without causing a shear failure or excessive settlement. The pressure which the existing soil can easily withstand against the defined load is called allowable bearing pressure.

- **Determination of Ultimate Bearing Capacity**

The ultimate bearing capacity of a foundation is determined by the methods listed below:

1. Using theoretical analysis. (Terzaghi's analysis, Skempton analysis, Meyerhof analysis.)

2. Using plate load test results.
3. Using penetration test results.
4. Using building codes.

How to Design Economical Foundations and Prevent the Construction Issues at Site:

Foundation construction problems on the site and costs may include but are not limited to:

- Construct the foundation shallow, if possible, per design - It is recommended to make the foundation as shallow as possible. The size should be optimized to sufficiently support loads and withstand environmental influences and excessive foundation depth and width should be prevented.
- Awareness and knowledge of structural engineer - structural engineer's assumptions, ground condition variability and practicality of construction can help in bringing economical design
- By using simple and reliable form works - revision of construction techniques and costs can help to ensure economical budget.
- Site investigation reliability - must be precisely done so that the construction work can be planned and executed properly, and undesired events can be prevented.
- Construction work Pace depends on the planning of construction management practices and can favor a lot in keeping budget in control.
- Bringing variations in foundation plans and designs when necessary for different joints
- It is recommended to make the foundation as shallow as possible. The size should be optimized to sufficiently support loads and withstand environmental influences and excessive foundation depth and width should be prevented.
- A continuous revision of construction techniques and costs because not only the economy of design varies considerably.
- To prevent the future problems like differential settlement or any other problems in the future, the careful soil exploration is especially important.

The reliable soil investigation part plays key role in deciding on the design and construction of proposed project.

- Excavation practicum affects, vibrations, and moving of heavy equipment close to construction site may affect the strength of the construction particles. The compaction of ground and water table fluctuations could cause damages to structures and utilities close to the project. So structural engineer must pay attention to all these possibilities.
- The influence of changes in the dimensions, shape and rigidity in the foundation construction need to accommodate the settlement and movement of the foundation.
- The other factors such as shrinkage of clay, frost heave, sulphate attack on trees, construction of new structure close to the building can generate vibrations that may affect the foundations and structural engineer and project engineer must pay attention on this matter

III. Implementation details of PBL based internship section of soil testing and foundation design

- **Method of learning:** Project Based Learning
- **Approach:** Problem solving by Project based learning practicum for outside classroom learning.
- **PBL based Internship program's assigned practicums for students**

Day 1 Activity 1: 2 hours

Reviewed and analyzed the soil testing report for construction site.

- Group of students reviewed the soil testing report for the construction site and understood and analyzed the factors which control the RCC foundation design for the proposed building. Students inquired and discussed the need of calculating load bearing capacity of soil for RCC foundation design purposes.

Day 1 Activity 2: 2 hours

Comparing and understanding RCC foundation Theoretical design with Construction design

- Student Groups compared and understood the RCC foundation construction design per NBC standards with classroom or theoretical learning. Students

identified the material grades and standards per NBC to be used during RCC foundation construction.

Day 2 Activity 3: 4 hours

RCC foundation and other project related construction drawings.

- Project activity for group of Students was to understand and identify different parameters to include and depict per NBC standards in the RCC foundation construction drawings as compared to the classroom practice drawings as with discussions with the site design engineer. Students reviewed and understood to relate architectural, structural, electrical, utilities drawings and how the construction practicum were coordinated per these construction plans accordingly. Students learned the standard drawing format of construction drawings.

Day 3 Activity 1: 4 hours

Visited and monitored field tests at GERI (Gujarat Engineering Research Institute)

- Project activity for group of students was to understand and identify different parameters of soil testing. Students performed simple field tests with the GERI Field supervisors at the facility and understood field soil sampling techniques and procedures while collecting and transporting samples to the facility for soil testing. Students identified the importance of soil's bearing capacity tests and their importance in foundation construction. Engineers also shared the draft copy of soils report prepared based on the bearing capacity of soil as per norms and regulations followed per building code.

- **Assessment for PBL based internship group practicums**

- Daily and Weekly reports: Summarizing field work practicum for day and week.
- Post-test and discussion were conducted at end of the PBL - internship program.
- Final report and presentation included the field knowledge and experience attained by conducting topic related PBL - internship group practicum.

- **Learning outcomes of the implemented PBL based internship program's group practicums.**

- Students can analyze the soil testing procedures.

- Students can analyze the soil testing report and explain the role of soil's load bearing capacity for RCC foundation design.
- Students can analyze the RCC foundation design based on soil report.
- Students can identify the RCC foundation construction design in reference to the theoretical design.
- Students can relate the different construction drawings such as architectural, electrical, structural, utilities with project

- **Pictures of the PBL based Internship practicum at GERI and internship site.**
- **Soil Testing and Foundation Design**

Picture 4.20 Students interacting with team members and Gujarat Engineering Research Institute (GERI) engineers while conducting assigned project practicums.

Picture 4.21 Students interacting with team members and Gujarat Engineering Research Institute (GERI) engineers while conducting assigned project practicums.

Picture 4.22 Students interacting with team members and Gujarat Engineering Research Institute (GERI) engineers while conducting assigned project practicums.

Picture 4.23 Students discussing and interacting with team members and site supervisors for the foundation design plans for assigned project practicums.

- **Researcher's observations:**

➢ The confidence and communication skills of the program participants had improved significantly while interacting with researcher and the site supervisors. In small groups students felt more connected to ask and discuss the queries with the team members, site supervisors and researcher.

- Students improve their technical competency by reflect the classroom learning while observing and participating in field practicum for soil testing procedures.
- Students showed great discipline and interest in learning about the soil sampling, testing and soil report during GERI visit while interacting with engineers at GERI.

4.3.1.5 Reinforced Cement Concrete (RCC) Foundations Construction

4.3.1.5.1 PBL based Internship program's RCC Foundations construction information

I. Sub sections

1. Explore local source and quality for Construction Material Procurement Procedures
2. Reinforced Steel grade and BBS- Bar Bending Schedule.
3. Form work calculations for different types of foundations.
4. Concrete mixers and Grade wise Concrete Mix quantity ratios for foundations.
5. Challenges in RCC foundation construction practices.
6. Monitor and supervise the construction work per construction drawings.

II. Learning Objectives

- Students will be able to identify the material procurement procedures and able to explore the local sources and quality of material by having discussions with site supervisor
- Students will be able to identify the steel grade and Bar bending schedule per NBC specifications.
- Students will be able to identify the need of concrete mixer per project requirements by having discussions with site supervisor.
- Students will be able to perform the calculations for form work quantities for different types of foundations under the supervision of supervisor.
- Students will be able to identify the challenges in the RCC foundation construction practices in reference to construction drawings.

- Students will be able to monitor and supervise the construction of foundations per construction drawings under the supervision of supervisor.

IV. Time assigned to conduct the daily assigned group project practicums of RCC Foundations construction

- On Site project work: 12 hours for the field activity. 4 hours for 3 days.
- Off Site theory review and daily report: 6 hours for reviewing project theory related to onsite/field practicum and putting together daily report.

4.3.1.5.2 Field practicums for RCC foundations construction.

I. Theory relating to PBL based internship program's group practicums.

- **Theory topics to review as per assigned group practicums of PBL based internship program**

➢ Group of students reviewed the procedure for Construction material Procurement.

➢ Group of students reviewed and studied Reinforced Steel Bar bending schedules per NBC standards.

➢ Group of students reviewed and understood the calculations for required form work quantities for laying down foundations.

➢ Group of students reviewed the types of concrete mixers and concrete mix grades for foundation constructions per NBC standards.

➢ Group of students reviewed challenges of RCC foundation construction practices.

- **Researcher provided background theory and lesson plans to be reviewed by students as per PBL based internship program's assigned practicums**

Material Procurement: The process of buying and obtaining other services from the manufactures, vendors materials is procurement. Procurement process should be done in a way to order correct quantity and proper value at the proper time. The selection of procurement procedure makes a major contribution to the projects budget and impacts the environmental, socio economical aspects of development in sustainable manne**r.**

Following are the activities or actions to perform during procurement process.

➢ Budget of project and construction budget separate.

➢ Grades and Specifications of products, materials, and required equipment.

- Purchase orders and payment mode
- Guidelines of building codes
- Bids or contracts
- Associated costs on top of the material cost
- Schedules of delivery and specified time frames.
- Construction schedule's coordination with material procurement

Construction procurement: Cost, Time and Quality are the main pillars of construction procurement. It is the process or a defined strategy to satisfy developer's development or operational needs regarding the proposed construction project.

Some of the steps are as following.

- Defining contract (type of contract, conditions, terms)
- Finalizing contractor and subcontractors
- Contract price to be established
- Economic considerations (Labor, materials, plants, capital)
- Construction procurement framework process can be divided into 2 ways:
- Processes during pre-construction stage (pre-contract)
- Processes during construction stage (post-contract)

Form work

It is the temporary structure provided before pouring down the concrete mix. The molds are removed when the concrete mix takes the permanent shape. In concrete construction is called as shuttering supported by falsework or formwork

Picture 4.24 Formwork for buildings Source: the constructor.org.

Types of Form work:

- Traditional timber formwork: This type of formwork is built out of timber on the site and is moisture resistant. The utility of this form work is economical only if the labor availability and lower labor cost is there.
- Engineered Formwork System: Metal frames, Steel or aluminum are used for the form work and is covered on the application side. The material used is prefabricated one.
- Re usable plastic formwork: The widely available, simple concrete structures are molded in these interlocking and modular systems. The lightweight and robust of panels was an advantage in using.
- Permanent Insulated Formwork. Assembly for this formwork happens on the site, and formwork stays in place for sometimes even after curing which fastens the process in gaining strength.
- Stay-In-Place structural formwork systems - used for columns and piers, assembled in site, made of prefabricated material, have hollow tubes and material or mixer fills in.
- Flexible formwork- It is not rigid but is light weight and are high strength sheets so that the fluidity and workability of concrete can be utilized for architectural visual building forms.

Measurements of formwork (shuttering): The cost to the contractor depends upon the quantity of formwork or as described in the contract. There are numerous ways for calculating the payments for the formwork. Usually, the formwork area is measured for the area in contact with concrete surface.

For example, the formwork is calculated as the surface area of all sides. The bottom of the footing and top of the footing are not included in calculating area. The measurement of formwork is taken as the combined surface area of two sides and bottom of the beam.

Issues in formwork measurements:

- Payment issues: discrepancies in calculating area may cause rifts for payments. The material cost, or type of form work also is a deciding factor for the cost of formwork.
- Complicated Building forms - to shape the concrete in a complicated way and makes the necessary formwork installation for it, make the budget costlier than the simple formwork installation as of the inability to reuse these forms

labor cost.

- Putting a better construction plan which will enable us to reuse the forms with number of times will help in construction cost effectiveness.

Bar bending Schedule

It is the schedule of reinforcement bars for proposed reinforced concrete. Bar bending schedule provides details of reinforcement cutting, bending lengths for the construction project. Bar bending table summarizes the schedule or other parameters of design. It shows the grade, size, length, bending, bent angles laps for each bar. This information or design schedules provides immense help to contractor in estimating quantities and determine the budget of the project.

Sl. No.	Details of Bar Shape	Length of Hooks	Total Length of Bar
1.	Diameter, [Straight bar], 4d, 4d, l	2[9d] = 18 d (both hooks together)	[l + 18 d]
2.	[Bent-up at one end only]], $x = \frac{l}{4}$ to $\frac{l}{6}$, D, 45°, x, l, D = Vertical distance (C/C) between bars	2[9d] = 18d (both hooks together)	[l + 18 d + 0.42 D]
3.	(Double bent-up bar) $x = \left(\frac{1}{4} \text{ to } \frac{1}{6}\right) l$, l, D, 45°, 45°, x, x	2[9d] = 18d (as for above cases)	[l + 18 d + 2 × 0.42 D]
4.	(Overlap of bars), 40 d to 45 d, (Joint)	2[9d] = 18d	Overlap length at joint = [(40 d to 45 d) + 18 d]
5.	l_1, l_2	[Here, one hooks height = 14d] 2 × (14d) = 28 d	[$l_1 + 2l_2$ + 28 d]
6.	l_1, l_2	2(12d) = 24 d	[$2(l_1 + l_2)$ + 24 d]

Picture 4.25 Typical Bar Bending Schedule. Source: blogspot.com.

Advantages of Bar Bending Schedule - improves and clarifies the design details to the site supervisors, structural engineer. It saves time as materials and cost of the construction work.

- The onsite work of cutting and bending of bars can be reduced and it be less hassle as with the provided schedule, contractor can have the job done at off site as well. It makes the execution faster and save the time for supervising the labor during bending activity. Though transportation cost may be added up but help in saving the wastage of bars which keeps project budget in limits.
- Graded material like Fe 500 can save 10% steel as compared to Fe 415 but it should be done as per structural engineer's guidelines.
- Quality control can be improved as it gives a provision to test the bar material for needed strength as per standard codes.
- Site engineer can visualize and monitor the reinforcement needs of each structural member by comparing bar bending schedule design as per load requirements and provides ease for procurement department to schedule orders and estimation.
- Procurement ease with provided BBS helps in transporting materials to far off sites without any delay in construction works.
- The theft of materials from site can be controlled if the defined quantities information is provided to site supervisors.
- The BBS onsite location can be placed near excavation, foundation, and construction site area to have it immediately available when needed. It reduces time and is helpful when concrete pouring process begins. Hence, provide efficiency in the overall project and manages construction time.
- Benchmarks can be maintained for steel quality and concrete works. Site engineers can verify and approve the bar bending design and material for the better-quality control before the placement of reinforcement bars.
- Easy and fast bills can be prepared with it and transparency can be shown in the quantities and costs.
- The complete safe design with engineering formula as per engineering standard codes can approximate the estimation for steel reinforcement.

- Reliability of accuracy in bars cutting and bending is the major advantage of BBS, that way the cost can be immensely reduced, and the strength can be attained per required standard.

How to Pour Concrete

- Préparation - The area of all objects or material must be cleared which interferes in the pouring process. This may include vegetation, rocks, previous concrete or abandoned structures.
- Prepare subbase for the material on which the concrete rests. Gravel fill is used as a subbase, but sometimes native soil can be compacted well with other subbase material. Sub grade is soil underneath the subbase. The stability of sub grade is especially important as if it shifts or move as strength of the concrete and structure may get affected.
- The proper compaction of sub grade is important, and it needs to stabilize before the addition of subbase. Open Fine grade stone can be chosen as subbase as the water can percolate through and its economical on the other side. But there is a limitation that these open fine grade stones do not attain compaction well. Though Closed fine grade stones are quite compatible but are expensive for the budget. Subbase is 4-8-inch-thick subbase with chosen material, and then compact it with hand tamper or plate compactor.
- **Prepare a form.** Form is a temporary structure secured by special nails or supports and is built or placed around the pouring area. A good form work will provide a better finish on concrete. The angles or rectangular and other shapes need to be put together precisely and the required slope should be given for giving away the water. The slope can be adjusted with the scale of structure.
- **Consider adding wire mesh or rebar** to your form (optional). Wire mesh and rebar are used for added stability, especially on heavy load-bearing structures, such as driveways. If you are pouring concrete for surfaces onto which you are not likely to put a lot of weight, it would probably be overkilled to add wire mesh/rebar. Both have their advantages and disadvantages:
- **Adding wire, mesh, or rebar**. For additional stability wire mesh or reinforced bars are used. Mostly heavy structures are designed with the

complete reinforcement design such as types and diameter of rebars and their spacing between them. Wire mesh is used on structures where the possibility of small crack may be there even though it did not provide much of stability.

- **Mix your concrete.** Mixing concrete: Concrete is mixed as per provided specifications for water cement and aggregate. The workability and strength factors needed to be kept in mind for poring purposes. The mixer can be mixed with separate ways (discussed in detail later) machine mixer, hand mixer.
- **Pour the concrete into the mold.** Pouring concrete into the mold can be done by mixer trucks or load in wheelbarrows and tilt them where required or pressurize it to top in pipes for multi rise tall buildings. The workers must spread the concrete with shovels immediately after pouring for proper settling of it.
- **Screed the top of the concrete -** Screed the top of concrete by screening tool and flatten it out immediately. With the large floating device do some of compaction on poured concrete, unless water bleeding becomes visible.
- **Make control joints every 5 - 6 feet (1.8 m) with a groover**. All 5- 6 feet make control joints of a quarter of thickness with a groover. These joints are needed to adapt the shrinkage and expansion of concrete as of weather changes.
- **Create traction.** By creating traction, we can make the rough texture for concrete surface for less slippery. A rough surface can be created with soft brush, and you can use the trowel and slide it over the surface. The grooves of rough texture should not be so deep so that water can withstand there.
- **Cure and seal the concrete**. Curing is the crucial factor in construction engineering. Proper curing helps in attaining strength to the concrete. Concrete should be cured for 28 days. The sealant should be provided for concrete cure to prevent all the possible cracks and other discoloration issues. The sealant of concrete is recommended right in the beginning.
- **Maintain your concrete.** Concrete maintenance is important in maintaining the better look of the concrete. Seals should be occasionally maintained for better surface finish

Concrete Mixers

A mixer used to mix all the components of concrete like cement, aggregates, water to form a concrete mix. Several types of mixing are done by available kind of mixers. The typical mixer can be picked depending upon the type of mixing needed. The concrete mixer revolves the drum to mix the components and it can be done manually and mechanically. Mechanical mixers are opted for large scale works while small scale projects can accommodate manual and portable concrete mixers. Time management and ahead preparation should be there before concrete mixing starts for better workability and strength aspects.

Types of Concrete Mixers:

There are two broad types of concrete mixers:

- Batch mixers
- Continuous mixers

Batch Mixers can be divided into:

- Drum Types Mixer
- Pan Type Mixer
- Drum type Mixer:
- Tilting drum mixers
- Non-tilting drum mixer
- Reversing drum mixer

Batch Concrete Mixers

Concrete mix obtained by batch mixers is in the form of batches from time to time. It is widely used machines for concrete mixing. Hence the mix is bathed in batch from time to time that is why is called batch mixers. The titling downwards will discharge the concrete mix. It is the rapid discharge process and can also be used for large projects. Drum is tilted downwards by gravity hence no segregation of material will happen. Generous size aggregates concrete mixes work well with this tilting type mixers.

Picture 4.26. Batch concrete mixer Source: theconstructor.org

But the efficiency of mixer depends on following:

- Shape of the drum
- Angle of the drum
- Size of blades
- Angle of blades

The mixer sticks to the bottom of the drum hence it becomes challenging to screw it off. Sometimes a layer of cement mortar is applied to prevent such sticking.

Non-Tilting Drum Mixers

No tilting happens in non-tilting drum mixers and drum rotates at horizontal axis. A chute is arranged in inclined position for discharging the concrete mix. Two ends are open with based and after adding all the material one end is closed and mixer is collected from other end. Non-Rapid discharge may result in segregation if timeline to collect and pouring not managed well. This mixer is suitable for small size aggregate and can be used for small projects.

Picture 4.27. Non-Tilting Drum Mixers Source: theconstructor.org

Reversing Drum Mixers

It's like non-tilting but rotation of drum is in one direction for mixing and opposite in other direction. Hence its good for dry concrete mixers.

Picture 4.28a Reversing Drum Mixers Source: theconstructor.org.

Pan Type Concrete Mixers

It consists of a circular pan in which concrete is mixed and blades are arranged in star shape inside pan. Two types of mixers are available, with star blades rotate about vertical axis and circular pan rotates in static position. Mixing is efficient in both cases and is mixture collected through the central hole in the pan. Scrapper blades prevent the sticking of concrete sticking the pan.

Picture 4.28b Pan Type Concrete Mixers Source: theconstructor.org.

Continuous Concrete Mixers

The continuous mixer is used for loading, mixing, and discharging of mix and the mixing is done until the work is completely done.

Picture 4.29 Continuous concrete mixers Source: theconstructor.org.

The loading is done by screw feeders and continuous mixtures are used for large projects, bridges, and construction of high-rise buildings. It is also called ready mix concrete.

Concrete mixing transport trucks

These in-transit trucks solve the purpose of mixing and transporting the concrete to the construction site. Dry materials with optimum quantity of water can be charged in for mixing. The central mix plant also provides the mixed concrete to transport to the construction site. The time management of transporting material and mixing should be managed by construction manager as to maintain materials agitation and cohesion until delivery and pouring.

Picture 4.30 Concrete mixing transport trucks Source: theconstructor.org.

Biggest challenges for construction projects:

Challenges at construction sites are faced by small- and large-scale projects. Large projects had many problems compare to small projects and some of the common problems related to construction projects are:

- Lack of Skilled Workers.
- Lack of Communication between supervisors and laborer.
- Unreliable and unprofessional Subcontractors.
- Mismanagement of Schedule.
- High Insurance Costs.
- Changing market and investor's minds.
- Financial issues.
- Documentation and paperwork.

Challenges in construction of foundations can be same as building construction in but some specific are stated below but are not limited to following only:

- Swelling of soils due to numerous reasons may cause differential settlement.

- Excavation practicum for foundation construction in waterlogged or low water table sites poses a challenge for the site engineer.
- Availability and required workability of building material as per required Grade Mix.
- Frost, weather, precipitation conditions may change the moisture content of soil which can delay the proposed schedule of construction practicums.

II. Implementation details of PBL based internship for section of RCC foundations construction

- **Method of learning: Project Based Learning**
- **Approach:** Problem solving by Project based practicum for outside classroom learning.
- **PBL based Internship program's assigned practicums for students**

Day 1 Activity 1: 4 hours

Reviewed and understood the material procurement procedures and Bar bending schedules.

- Group of students understood material procurement procedures as per discussions with the Project manager and Site supervisor. Students identified different factors and their importance in material procurement in building projects
- Group of students understood and assisted the site supervisor and contractor in BBS Bar bending schedule. Students monitored the bar bending schedules per site construction drawings under the supervision of site supervisor and identified the difference in depiction of BBS for construction drawings compared to classroom steel design drawings.

Day 2 Activity 1: 4 hours

Form work calculations and Concrete mixers for Grade wise Concrete Mix quantity ratios for foundations.

- Student groups understood and performed the form work calculations with site supervisor's /engineer's for constructing foundations. Students identified the need for concrete mixer and monitored and examined the working of concrete mixer's while batching out concrete mix design and grade as required per foundation design drawings under the supervision of site supervisor.

Day 3 Activity 1: 4 hours

Identified Construction site challenges and monitored and supervised the RCC

Foundation construction practices.

- Project based learning activity for internship program for group of students was to identify different parameters of onsite construction practices compared to theoretical learning of it. Group of students identified and listed down the construction site challenges during transitioning of foundation construction drawings (from paper) to actual onsite construction.
- Students monitored and assisted the site supervisor during construction of RCC foundation. Students communicated with the contractor and labor from their experience to get an insight about challenges they faced while laying down the foundations as per construction drawings.

- **Assessment for PBL based internship group practicums**

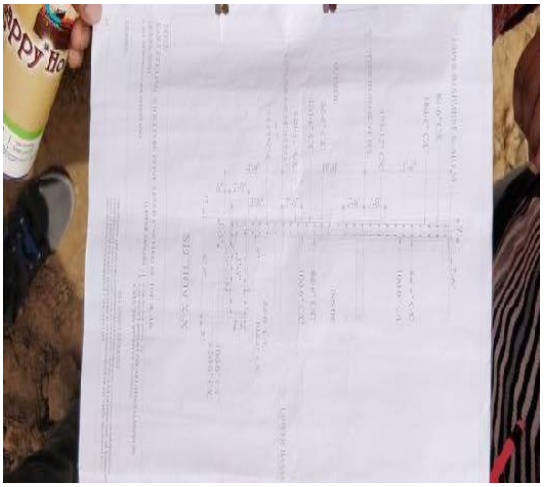
- Daily and Weekly reports: Summarizing the field work practicum for day and week.
- Post-test and discussion were conducted at the end of the PBL internship program.
- Final report and presentation included the field knowledge and experience attained by conducting topic related PBL based internship group practicums.

- **Learning outcomes of the implemented RCC foundations construction group practicums.**

- Students can identify the material procurement procedures and can explore the available local sources and quality of material.
- Students can identify the steel grade and Bar bending schedule per NBC regulations.
- Students can identify the need of concrete mixer per project requirements by having discussions with site supervisor.
- Students can perform the calculations for form work quantities for several types of foundations
- Students can list the challenges in the RCC foundation construction practices.

- Students can monitor and supervise the construction of RCC foundations per construction drawings under the supervision of supervisor

- **Pictures of the PBL based internship program's implemented group practicum.**
  - RCC Foundations Construction



Picture 4.31 Students discussing and monitoring RCC Foundations Construction drawings.

Picture 4.32 Students discussing and monitoring RCC Foundations Construction

Picture **4.33** Students observing and monitoring the excavated area for reinforcement

Picture 4.34 Students discussing and monitoring reinforcement bar bending practicums

Picture 4.35 Students observing and monitoring the excavated area for reinforcement design of foundation construction

Picture 4.36 Students monitoring reinforcement bars mesh as laid per steel reinforcement drawings

Picture 4.37 Students monitoring the concrete pouring project practicum.

- **Researcher's observations**

➢ Students gained knowledge about materials procurement, waste reduction, proper handling and storing of materials. The researcher observed the gained knowledge reflectiveness when few students did identify some mishandled material on the construction site and inquired the concern with site supervisors.

➢ Students coordinated the Bar bending mesh formed on site with Bar bending schedule drawings and monitored the installation of Bar bending mesh for foundation area.

➢ Students monitored, observed, shared and discussed their queries, learning observations during monitoring concrete pouring for foundations at the construction site for field practicum with site supervisor, researcher and in their respective groups.

4.3.1.6 Building Construction

4.3.1.6.1 - PBL based internship program's Building construction.

I. Sub sections

1. Implementation of NBC and IS regulations in building construction practices.
2. Installation of on-site batching plant.
3. Concrete Pouring Methodology.
4. Grade wise Concrete Mix quantity ratios for building construction.
5. Challenges in building construction practices.
6. Monitor and supervise the building construction work as per designed construction drawings.

II. Learning Objectives

- Students will be able to identify the implementation of NBC and IS regulations for building construction practices.
- Students will be able to explore the Concrete Pouring methodologies of concrete mixers by having discussions with site supervisor.
- Students will be able to identify the Grade wise Concrete Mix quantity ratios for building construction as per construction drawings.
- Students will be able to monitor and supervise the building construction practicum as per construction drawings under the supervision of supervisor.
- Students will be able to identify the challenges in the building construction practices with reference to construction drawings.
- Students will be able to identify the other construction project related practicum or issues while communicating with site supervisor.

III. Time assigned to conduct the daily assigned group project practicums of Building construction.

- On Site project work: 12 hours for the field activity. 4 hours @ 3 days.
- Off Site theory review and daily report: 8 hours for reviewing project theory related to onsite/field practicum and putting together daily report.

4.3.1.6.2 - Field Practicums for building construction

I. Theory relating to PBL based internship group practicums

- Theory topics to review as per assigned group practicum of Building construction

- Group of students reviewed the implementation of NBC and IS regulations in building construction practices.
- Group of students studied the onsite concrete pouring methodology procedures.
- Group of students reviewed and understood the need, installation, and maintenance procedure of concrete mixers.
- Group of students reviewed the Grade wise Concrete Mix quantity ratios required for construction elements like beams, slabs, lintels as per designed construction drawing.
- Group of students listed down the practicum related to site construction practicum.
- Researcher provided background theory and lesson plans to be reviewed by students as PBL based internship program's assigned practicums.

RCC Building Construction

For specifications and standards in building practices for cement, aggregate and concrete mixes, an Indian Standard Codes and National Building Code should be referred.

How to Pour Concrete

Part 1 - Préparation

1. Preparing subbase for the material on which the concrete rests.
2. Prepare a form.
3. Consider adding wire mesh or rebar

Part 2 - Pouring

1. Mix your concrete.
2. Pour the concrete into the mold.
3. Screed the top of the concrete.
4. Make control joints every 5 - 6 feet (1.8 m) with a groover.
5. Create traction.
6. Cure and seal the concrete.
7. Maintain your concrete.

Grades of Concrete

Concrete grades are expressed according to the compressive strength as M10, M20, M30. The respective ingredient proportions of Cement: Sand: Aggregate known as Mix. The Minimum grade of concrete for Plain Cement Concrete (PCC) is M15 and for Reinforced Cement Concrete (RCC) is M20
mix. Usually the percentage falls under 0.4 to 0.6 per IS Code 10262 (2009) for (M10, M15, M20, M25). The strength of concrete is directly affected by water cément ratio. The field test of concrete Slump test can test about the concrete mix's workability and consistency, and we recommended to conduct before casting.

* Concrete mixers, grading, challenges during construction can be reviewed from provided theory of foundation construction. *

- **Implementation details of PBL based internship section Building construction project practicums**
- **Method of learning: Project Based Learning**
- **Approach:** Problem solving by Project based practicum for outside classroom learning.
- **PBL based internship program's assigned practicums for students**

Day 1 Activity 1: 4 hours

Reviewed and understood the Implementation of NBC's standards, NOC's, permits required in building construction practices.

- Group of students identified the procedure and ways to implement NBC's standards in building construction drawings and on-site construction practicum.
- Students learned about the NOC's - No Objection Certificate and permits required before starting the construction
- Students compared and identified the differences of project/onsite based learning with the theoretical classroom knowledge by monitoring, assisting and understanding how the code standards are implemented and followed while transitioning from construction drawings to actual construction of buildings.
- Group of students understood the procedure of installation of onsite batching plant or RMC plant with the site supervisor and identified the and working of RMC plant and other challenges while observing

the onsite practicum in comparison to the classroom learning.

Day 2 Activity 1: 4 hours

Concrete Mixer, pouring methodology and grade wise concrete mix quantity ratios for building construction.

- Student Groups observed, monitored, and understood the concrete mixer's pouring methodology as required by construction drawings with site supervisors and engineers. Students identified the differences they observed in onsite pouring concrete methodology compared to theoretical learned methodology.
- Students monitored and examined the concrete mix design and type of grade required per construction drawings under the supervision of site supervisor or contractor.

Day 3 Activity 1: 4 hours

Identified construction site challenges, practicum related to Project construction, monitored, and supervised the building construction practices.

- Project learning activity for group of students identified different parameters of onsite construction practices compared to theoretical learning of it. Group of students identified and list down the construction site challenges during transitioning of building construction drawings to actual onsite construction.
- Students monitored and assisted the site supervisor during construction buildings. Students will communicate with contractor and labor from them experience to get an insight about challenges they face while building construction or components as per construction drawings.
- Students identified other site or project related practicum such as material handling, waste management.
- Assessment for PBL based internship group practicums
- Daily and Weekly reports: Summarizing the field work practicum for day and week.
- Post-test and discussion were conducted at the end of the PBL-internship program.
- Final report and presentation included the field knowledge and experience attained by conducting topic related PBL based internship group practicum.

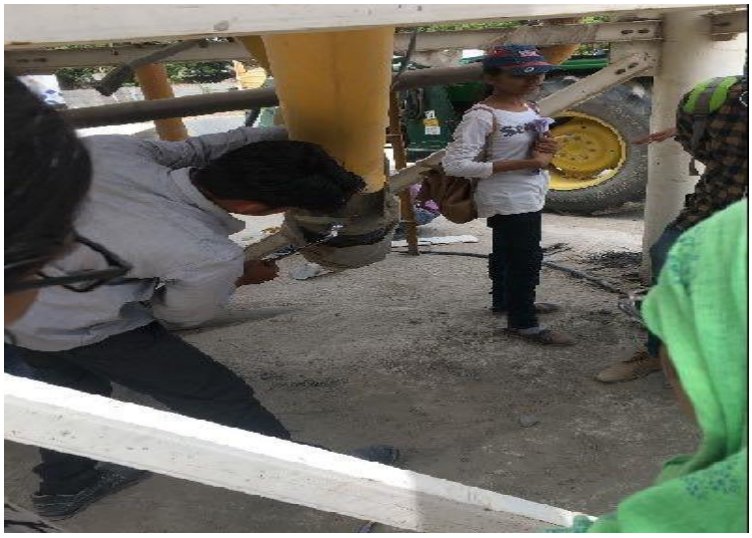
- Learning outcomes of the implemented PBL based internship program's group practicum.
- Students can identify the implementation of NBC and IS regulations in building construction practices.
- Students can identify the various Concrete Pouring methodologies of concrete mixers by having discussions with site supervisor.
- Students can identify the Grade wise Concrete Mix quantity ratios required for building construction per NBC, IS codes and construction drawings.
- Students can monitor and supervise the building construction practicum per construction drawings under the supervision of supervisor.
- Students can identify the challenges in the building construction practices in reference to construction drawings as well as onsite construction practices.
- Students can identify the other construction project related practicum or issues while communicating with site supervisor.

- **Pictures of the PBL field Internship program's conducted group practicum.**

Students observing and monitoring building construction practicum as per building design drawings.

Picture 4.38 Students observing and monitoring building construction practicum as per building design drawings.

Picture 4.39 Students discussing and monitoring reinforcement bar bending practicums



Picture 4.40 Students discussing and monitoring ready mix concrete batch plant Practicums.

- **Researcher's Observation:**

➢ Students coordinated the Bar bending mesh formed on site with Bar bending schedule drawings and monitored the installation of Bar bending mesh for foundation area.

➢ Students monitored the RMC plant mixing process and SCADA software to operate it automatically.

➢ Students followed the quality control procedure in a team to identify the quality of construction materials used at the site

4.3.1.7 Precast Construction

4.3.1.7.1 PBL based Internship program's Precast cnstruction Information

I. Sub section

1. Implementation of NBC and IS regulations in Precast construction practices.
2. Visit the Precast manufacturing plant
3. Challenges in transportation and use of Precast structures.
4. Advantages and disadvantages of Precast Construction.

II. Learning Objectives:

- Students will be able to identify the implementation of NBC and IS regulations in Precast construction practices.
- Students will be able to explore the Precast manufacturing/ construction procedures by having discussions with Precast Manufacturing Plant Engineer.
- Students will be able to explore the use of Precast structures in Construction Industry.
- Students will be able to identify the challenges of transportation, management and use of Precast structures at construction sites.
- Students will be able to identify the advantages and disadvantages of using Precast structures at construction sites.

III. Time assigned to conduct the daily assigned group project practicums of Precast construction.

- On Site project work: 4 hours for the field activity. 5 hours per day.

- Off Site theory review and daily report: 3 hours for reviewing project theory related to onsite/field practicum and putting together daily report.

4.3.1.7.2 Field Practicums for Precast construction.

I. Theory relating to PBL based Internship program's group practicums

- **Theory topics to review as per assigned group practicum of PBL based Internship program**

➢ Group of students reviewed the Implementation of NBC and IS specifications in construction or manufacturing of Precast units or structures.

➢ Group of students studied the Precast manufacturing procedures per building codes.

➢ Group of students explored and studied the Project construction sites where Precast structures are/were used.

➢ Group of students studied about the challenges in transportation and use of Precast structures.

➢ Group of students studied the advantages and disadvantages of Precast structures.

- **Researcher provided background theory and lesson plans to be reviewed by students as per PBL based internship program's assigned practicums.**

Precast Construction:

Precast construction is the form where standard or designed mix of concrete is poured in specific molds to give different shapes of building components. It is the construction product produced on offsite, cured and stored in controlled environment, which is later transported to the construction or project sites per needs.

Precast Concrete Construction – Process and Advantages

➢ Precast concrete construction has many advantages overcast-in-situ concrete structures as well as other steel, wood and masonry structures.

➢ Faster, more efficient construction process can be provided by Precast concrete construction.

➢ The precast can be helpful in flexibility of design but can be adjusted in parameters like span length, strength, layout, finish.

➢ The joints in precast concrete units are completed as monolithic concept like

cast in situ structures.

- Precast construction can be very costly depending upon the type of structural component.
- Lot of features like long span, connections, transportation restrictions, detailing of structures, manufactures, erection and serviceability of components are the possibilities experienced during precast construction process.

Properties of Precast Concrete Construction

- Faster Delivery as not affected by weather and labor issues.
- High standard of workmanship to reduce potential for accidents and skilled worker's shortage.
- Good quality finish
- Better thermal properties can be developed.
- Innovative materials can be made and tested for strength.

Functions of Precast Concrete Construction

- Primary Functions
- Water resistant
- No air leakage
- Control light
- Control conduction and radiation of heat
- Sound absorbing
- Wind force resistant
- Control water vapour
- Expansion/contraction joints
- Movements in Structural joints
- Fire resistant
- Weather protecting
- Easy installation
- Architectural precast concrete contributes in designing facades for different types of buildings used for numerous operations such as residential, hospitals, sports stadium.

Precast concrete provides:

- Thermal protection

- Rain screen
- Good Lifespan
- Economical budget
- Better quality if monitored.
- Variety of finishes
- Elements in Precast Concrete Building Systems:

Following are the elements constructed in precast concrete building construction:

- Precast concrete frame
- Precast concrete wall
- Precast concrete floor

Precast Concrete Frame Construction

Precast frame construction is a structural component which is incorporated into the building project at construction site. The frames are constructed to achieve strength as well as architectural decorative design. The maintaining of strength properties and visual look is to be accommodated during the precast construction.

Picture 4.41-a Precast Concrete Frame Construction Source: Wikipedia.

Construction Process :

The construction of precast concrete frames is designed as structural members with heavy reinforcement. The site supervisor needs to make sure that proper connections are made to connect beams and slabs to the Precast frame. The connections should be clear and precise in keeping strength and visual appearance of the Precast frame.

Benefits of using Precast Concrete Frames:

- Speedy process and no weather effects.

- Fabrication as precast and bringing onsite can go simultaneously
- Have good quality finish compared on cast in situ as on onsite skilled workers shortage.
- More space and less hassle can provide high standard of work if monitored appropriately.
- Offsite work reduces potential of onsite accidents.

Precast Concrete Wall Construction

Precast concrete wall construction is used in housing and apartments. The walls or classical brick masonry wall are some examples of precast walls. The precast walls are usually used in domestic purposes for outer or inner walls.

Picture 4.41-b Precast Concrete Wall Construction Source: Wikipedia.com

Precast walls offer the advantage of speed of construction, smooth surface finishing, acoustic insulation, and fire resistance.

Precast Concrete Floors

Types of precast concrete floors:

- Ribbed floors
- Hollow floors
- Concrete roof elements
- Hollow core floors
- Massive slab floors

It consists of different units and connects longitudinally with the good grouting. Precast floors are manufactured in total or partial ways as per the need of the project.

Sometimes precast and cast in situ floors are connected.

Picture 4.42 Precast Concrete Floors. Source: Wikipedia.com

The advantage of precast floor is speedy construction, variety of options, large span, economical and time management.

Advantages of Precast Concrete Process

- Efficiency in Structural construction.
- Flexibility
- Optimum use of materials
- Speedy construction
- Quality maintained
- Adaptability per demand.
- Can be Environment friendly

Advantages of Precast components.

- Economical than Brick construction
- Flexibility in construction or manufacturing
- Can be made more durable with no mortar joints
- Installation is easy and quick
- Better than wood fences as no maintenance required.

Disadvantages

- Strength attained at precast can be an issue
- Less skilled workers may do poor workability and finish on components.
- Contractual problems may arise for precast and cast in situ.
- Transportation in one piece can be challenging
- The structural connections to cast in situ can be an issue.
- The vibrations during transportation may cause cracks in structural component.

- The quality of material used for precast components can be compromised one.

II. Implementation details of PBL based internship section Precast construction project practicums.

- **Method of learning:** Project Based Learning
- **Approach:** Problem solving by Project based practicum for outside classroom learning.
- **PBL based Internship program's assigned practicums for students**

Day 1 Activity 1: 5 hours

Observed, conducted workshop practice at Precast structure manufacturing plant and discussions with manufacturing engineers:

- Group of students observed and understood the procedure and ways to implement NBC's standards in manufacturing precast structures. Students identified the challenges in manufacturing and transporting precast structures to the construction sites. Students molded few simple precast components at the precast workshop area. Students explored about the advantages and disadvantages of using precast structures at construction site. Students understood Precast structures utility in construction projects and identify the precast structures that has been used in construction developments.

- **Assessment for PBL based internship group practicums**

- Daily and Weekly reports: Summarizing the field work practicum on daily and weekly basis.
- Post-test and discussion were conducted at the end of the PBL-internship program.
- Final report and presentation included the field knowledge and experience attained by conducting topic related PBL-internship group practicum.

- **Learning outcomes of the implemented Precast Construction group practicums.**

- Students can identify the implementation of NBC and IS specifications in precast manufacturing/construction practices.
- Students can identify manufacturing/construction procedures of Precast units.

- Students can identify the need and utility of Precast structures in Construction Industry.
- Students can identify the challenges of transporting, managing and use of Precast structures on the construction sites.
- Students can identify the advantages and disadvantages of using Precast structures in construction industry.

- **Pictures of the PBL based internship program's implemented group practicum.**
- Precast Construction

Students working on the precast mold for a precast unit.

Picture 4.43 Students working on the pre casting mold for a precast unit at the Precast manufacturing plant for assigned project practicums

Picture 4.44 Students working on the precast mold for a precast unit at the Precast manufacturing plant for assigned project practicums.

Picture 4.45 Students worked and prepared precast mold for a precast unit at the Precast manufacturing plant for assigned project practicums.

Picture 4.46 Students worked and prepared precast mold for a precast unit at the Precast manufacturing plant for assigned project practicums.

- **Researcher's observations:**

➢ Students showed great interest at Precast manufacturing unit by forming the molds for manhole covers as a group practicum.

➢ Students showed the teamwork skills by working and sharing responsibilities of the group practicums as a team.

4.3.1.8 Construction Management and Administrative practices.

4.3.1.8.1 PBL based Internship Program's Construction Management and Administrative practices information

I. Sub sections

1. Construction Management with Primavera Software.
2. NBC Regulations followed for the tender documents.
3. Managing supply and demand of construction materials, equipment, budget and timeline practicum, labor.
4. Challenges in construction management practices.

II. Learning Objectives:

- Students will be able to explore the construction management with Primavera software under the supervision of construction site manager.
- Students will be able to identify the NBC regulations and procedures to be followed for filing of tender documents by having discussions with site supervisor.
- Students will be able to explore the management practices and skills required to manage supply /demand of construction materials, equipment, budget and timeline practicum and labor relations
- Students will be able to identify the job responsibilities of Construction site Manager.
- Students will be able to identify the challenges in Construction management as discussions with Construction manager.

III. Time assigned to conduct the daily assigned group project practicums of Construction Management and Administrative practices

- On Site project work: 8 hours for the field activity. 4 hours for 2 days.
- Off Site theory review and daily report: 6 hours for reviewing project theory related to onsite/field practicum and putting together daily report.

4.3.1.8.2. Field practicums for Construction Management and Administrative practices

I. Theory relating to PBL based Internship program's group practicums

- Theory topics to review as per assigned group practicum of PBL based Internship program

➢ Group of students reviewed the utility and instructions for using Primavera software in construction management practices.

➢ Group of students reviewed the NBC's regulations for preparing and submitting tender documents.

➢ Group of students explored and identified the management skills and practices to manage the demand and supply of construction materials, construction equipment, budget and timeline practicum and labor relations.

➢ Group of students reviewed and explored the responsibilities of Construction manager.

- Group of students reviewed the challenges in construction management practices.

- **Researcher provided background theory and lesson plans to be reviewed by students as per PBL based internship program's assigned practicums.**

Preparing Contract (Tender) Documents for Construction Projects

An agreement between two parties which they intend to bind together legally with the agreeing to the obligations of each party to other and their liabilities is known as contract or tender document. The contractor binds the contractor and the employer as contractor constructs the work as defined and described while employer pays for it in the scheduled manner and timing. The tender preparing task is a huge and involves lot of hard work, close detail attention and uniformity to achieve set of necessary documentation for a manageable contract.

A typical set of documents prepared for tendering will include the following:

1. Instructions to tenderers
2. General and conditions of contract
3. The specification
4. Bill of quantities or schedule of prices
5. Tender and appendices
6. The contract drawings

Instructions to tenderers

The instructions provide the information to the contractor about how to fill the details about the bonds, proposals of design, methods of construction, sources of materials, laborer's availability and rates, earthwork filling.

General and conditions of contract

The conditions of contract are the obligations of standard forms of contract. The conditions may get some amendments the employer wishes to modify them. The Standard conditions are included in specific reference and an attached revisions shows the changes have been made.

Bill of quantities or schedule of prices

The itemized list of items in which the tenderer quotes its price for the project. It gives the complete information. The detail quantities are shown with each item, its quantity, rate per unit, rate of each job and the consequent total price for those items.

This permits re-measure according to the actual quantity done under each item. Some bills contain many hundreds of items, classified by trade or according to a standard method of measurement; other bills contain a smaller number of items. Some other kind of work such as boring holes, excavation, issues during excavation may change in the bill of quantities.

Tender and appendices

The tender is the formal contract which includes tenderer's offer for accepting the contract for certain price. It contains may terms like making offer, completion time, damages, price to pay for delays, insurances, bonds. Tenderer accepts the contract terms and other related appendices in the offer.

The contract drawings

The complete picture of the contract is provided by the contract drawings. The complete drawings give better clarity if the drawings are complete and well labelled, hence less payment and material contrasts will happen. Sometimes contracts go with general drawings as reinforcement drawings are not included.

Types of Construction Contracts and Their Comparison

Different construction contracts are prepared for diverse needs of project. It is basically execution of job between two or more parties.

As per certain terms and conditions, a construction contract is an agreement to execute the construction works between two or more parties. It includes general and special conditions of agreement, details of construction work, time limits, payments and penalties for delays and rights and obligations of all participants.

Types of Construction Contract Documents

The necessary documents are prepared under the initial stages of construction project by the engineer and the consultant. These documents are contract documents.

Following are the types of documents in a construction contract:

- General conditions
- Special conditions
- Drawings and specifications
- B.O.Q (bill of quantity)
- Letter of acceptance
- Contractor bid

Conditions of Construction Contract

The relationship between owner and the contractor by defining each party's rights and obligations, and by specifying the method of payment, other actions for delays damages or conflict areas are termed in the conditions of contract.

Following are the conditions of contract for construction projects:

- General conditions of contract
- Special conditions of contract

General conditions of contract

They are standard terms that suit most projects, they include:

- Description of project
- Contract details
- Rights, responsibilities and obligations for the owner and contractor
- Schedule of project
- Method of payment
- Penalties and warranty of work.

Special conditions of contract

They are the modifications required to suit the uniqueness of the project, make the contract flexible for the nature of the project and achieve project objectives.

Selection of Type of Construction Contracts

One of the characteristics of construction projects is uniqueness. Every project has its extraordinary circumstances, so it's important to select the contract type which suits the project. The process of selecting the type of contract is developed by the owner.

Factors which affect the selection of construction contract are:

1. Project objective - The project objectives as per project type

2. Project constraints - variables and constraints to be considered.
3. Project delivery method - the interactions between both parties

Types of Construction Contracts

There are several types of contracts used in construction industry. With contractors and owner's perspective there are advantages and disadvantages for all. The types of construction contracts used in construction projects are following:

- Lump sum contract
- Unit price contract
- Cost plus contract
- Target cost contract

Challenges faced by construction manager

The set of practicums has been designed for construction projects. The success can be met by scheduling and meeting the details interns of cost, time safety resource allocation and quality. Project management is the methodology to achieve goals and objectives through the planned procedure of practicum so that quality, cost time, scope and safety requirements of proposed project can be met.

Source: Barrie and Paulson 1992

The construction management must be planned and managed in a way to prevent and control any issues that may arise up during the construction projects.

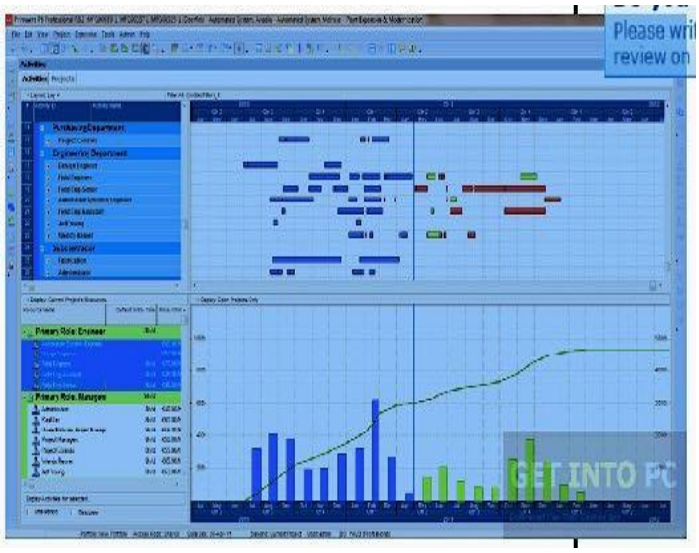
Some factors which may affect but not limited to are:

- The weather factor cannot be controlled by construction manager, but the proper planning and preparation may help in mitigating the effects and impacts of weather.
- Skilled and labor workforce is the necessity in construction work. Finding and recruiting adequate number of talented people can be difficult but possible if done in a planned manner.
- Safety measures are always a concern for construction manager and site supervisors. The workers itself must pay careful attention in keeping safety precautions to prevent any mis happenings.

- Time management is the main factor which balances the numbers of the project budget. Time is money for owners, builders, investors, and inefficient time management results in huge cost for labor and sometimes loss of clients or tenants and does make negative impacts of concerned project in the construction market.
- The environment guidelines and regulations are needed to be followed. The failure in environmental compliance may result in delay, termination, penalties, legal actions. The legal issues in contractual arrangements need to clearly be explained well to prevent any legal issues between different parties.
- The pressure of increasing government regulations had been another challenge for Construction manager. Failure to do can result in loss of license
- Socio political pressures for some construction projects may be an issue. Bank loan issues, religious sentiments, adjacent developments, existing businesses can impact the project timelines.

Primavera Software:

- Project management software hold prominent place in construction industry. MS-project, primavera are used to manage, monitor, and control project related practicum. These soft wares represent different verticals of construction project, practicum, labor, materials, time for activity can be tracked and monitored and replanned in case of delays. The ongoing and completed practicum are represented by bars.
- Primavera Project Planner manages several types of small, medium, and large projects throughout.
- In engineering and construction business, the Primavera program can help in managing the large and complex projects. The primavera software helps to propose, prioritize, plan, manage and control complex projects. The cost of the project can be monitored, delivery dates can be met, and the better time management decisions can be taken by using real time data and information.



Picture 4.47 Prima Vera software Source Prima Vera software tutorial

II. Implementation details of PBL based internship section construction management and administrative practices project practicums.

- **Method of learning**: Project Based Learning
- **Approach:** Problem solving by Project based practicum for outside classroom learning.
- **PBL based internship program's assigned practicum for students**

Day 1 Activity 1: 2 hours

Reviewed the Primavera software in construction management practices.

- Group of students explored and identified the management skills and practices required to manage the demand and supply of construction materials, construction equipment, budget and timeline practicum and labor relations. Group of students understood the use of primavera software in construction management practice while performing a site activity assignment with primavera software to get a better insight of the utility of software and identified its importance in construction management practices under the supervision of construction manager.
- Students communicated with site supervisors, office managers, laborer managers, labor and identified the challenges and solutions suggested by them on construction sites.

Day 1 Activity 2: 2 hours

Studied and explored tender documents

- Project learning activity for group of Students identified different parameters of preparing and understanding the format of tender documents in construction practices with discussions with Project manager.

Day 2 Activity 1: 4 hours

- Final review of Internship site and thanks note to site supervisors.
- Group of students shared their insight of learned different parameters of onsite construction practices compared to theoretical learning and designing of it with the researcher and site supervisors. Project engineers, Site supervisors and construction managers had provided feedback to students for the gained field knowledge and suggested, guided the students on career path and goals, which may benefit in their professional career ahead.

• Assessment for PBL based internship group practicums

- Daily and Weekly reports: Summarizing the field work practicum for day and week.
- Post-test and discussion were conducted at the end of the PBL - internship program.
- Final report and presentation included the field knowledge and experience attained by conducting topic related PBL based internship group practicums.

• **Learning outcomes of the implemented PBL based internship program's group practicums.**

- Students can identify the construction management with Primavera software under the supervision of construction site manager.
- Students can assist in the tender document preparation procedure per NBC's regulations.
- Students can assist in the management practices and skills required to manage supply /demand of construction materials, equipment, budget and timeline practicum and labor relations.
- Students identified the job responsibilities of Construction site Manager.
- Students identify challenges in Construction management Profession and practices.

- **Pictures of the PBL based internship program's implemented group practicum.**

Picture 4.48 Students discussing and interacting with team members and site supervisors for assigned project practicums

Picture 4.49 Students interacting with team members and site supervisors' while conducting assigned project practicums.

Picture 4.50 Students interacting with team members and site supervisors while conducting assigned project practicums

Picture 4.51 Students interacting with team members and site supervisors while conducting assigned project practicums.

Picture 4.52 Students discussing and interacting with team members and site supervisors for the foundation design plans for assigned project practicums

Picture 4.53 Students interacting with Civil engineering field knowledge expert for challenges and discussing to develop problem solving skills for construction management practices for the assigned project practicums.

- **Researcher's observations:**

- The confidence and communication skills while interacting with team members, researcher and the site supervisor had improved significantly.
- Researcher observed students or team members had taken group decisions of assigning penalty or more responsibilities while tackling with uncooperative team members.
- Students respectable attitude while interactions with daily laborers and their families for construction management practicum was commendable and applauded by the researcher.