Report on
Educational Field Visit for Diploma in Civil Engineering
Bagmati Irrigation Project (BIP)

Submitted By
Group-A

DEPARTMENT OF CIVIL ENGINEERING

JANA JAGRITI SECONDARY SCHOOL

(Affiliated to CTEVT)
RATNANAGAR-14 PITHUWA, CHITWAN

Submitted By:

- Bishal Simkhada 075/DCE/007
- Devnarayan Sah 075/DCE/009
- Partima Dawadi 075/DCE/024
- Rabindra Yadav 075/DCE/025
- Rajan Shrestha 075/DCE/026

Submitted To

Er. Bikash Poudel

Department of Civil Engineering

Table of Contents

Acknowledgement

First of all, I would like to acknowledge CTEVT for including "Field trip to an irrigation project in Nepal" in the syllabus. It helped us to understand the theoretical knowledge of irrigation and apply it in real life.

I would like to express our sincere gratitude towards the Department of Civil Engineering, Jana Jagriti Secondary School, for initiating and facilitating the Irrigation Field Visit under Instruction Committee, to enhance knowledge of Irrigation projects and canal design and various components of canal.

I would like to express our sincere gratitude to our Asst. Er. Bikash Poudel and all the other professors for taking us to Irrigation tour and assisting, suggesting, motivating and supervising.

Last but not the least, I would like to thank our friends, parents and relatives who have been very supportive during this period.

Submitted By:

- Bishal Simkhada 075/DCE/007
- Devnarayan Sah 075/DCE/009
- Partima Dawadi 075/DCE/024
- Rabindra Yadav 075/DCE/025
- Rajan Shrestha 075/DCE/026

2. Introduction / Background

2.1. Background of Irrigation Project in Nepal

The adoption of Nepal is not a new thing, as it appears to be because sufficient proofs are available in history of Nepal, which confirm that irrigation was being practiced not only during of RANAS SHAHI but even during the period of Lichhivi. The first national irrigation project in Nepal is Chandra Nahar during period of Chandra Smasher district (1965 B.S) irrigation command area of 10000 hectare and still in operation. In field work various parts headworks, intake structure, canals cross drainage structure etc. where carefully observed analyzed and studied in details.

More than 81% people are engaged in agriculture in Nepal. Agriculture is the main source of income in Nepal. As per record of Government of Nepal but,Ministry of Finance, 2054/55, more than 40% of national income comes from agriculture in nepal but the growth rate in agriculture is only 2.4%. Since the living standard of people is directly related to the income of people in any contry, there is an urgency to maintain and enhance the income of country like nepal. in case of our country, a major concern has to be given in the field of agriculture becouse of the fact thae major portion of the national income from agriculture. In order to extra major yields from agriculture and in turn enhance the economy of our country ,It is improve the agriculture system bye a better and more scientific method of irrigation apart from use of improved seed, fertilizeres etc.

The agriculture can be the source of employment to many people of our country that is currently jobless if we can utilize almost all the available arable lands. It is belived that more then 50% of the land of our country is used only for seasonal agrricultural products. Agrricultural pspertive plan has stressed the role of agrricultural in generation of employment opportunities and improving the living standard of people. This plan has also defined irrigation as a strategic inpout and has prescribe the conjuctive use of water in terai region. As the agrricultural sectorr contributes a signification ti the national income is a direct reflection of the change in agrricultural production.

If we can arrange better irrigation facilities in our country, the national income can be increasde significantly. When national income increases the per capital income will also increase. This is an effective indicator of economiv growth. Thus, it is essential to analyze the parameter of agrricultural growth. In this connection, irrigation is one of the most important to increase the agrricultural product particularly in the following two grounds. Firstly, we can increse the agrricultural product in the cultivated land with irrigation by enhancing the efficiency of rest auxiliary inpout. And, secondly, we can extensively cultivate the uncultivate agriculuural land peoviding irrigation national facilities.

However there han not been much significant steps taken place in Nepal. Out total 2.18-million-hectore irrigable land Nepal, 1.74 million hectors is in the plains of terai tegion and rest 0.44 million is situated in the valley of the hill. Out these potential irrigable areas just 1.766 million hectors has been provided irrigation and out of which some 1.06 million hectoes atre alredy developed (i.e., provided with infrastructure) for irrigation. Of the latter figure, however only about 71% is actually irrigated. That leaves some 29% of the development command area that could be brought under irrigation with relative ease, in addition to the nearly 700,000 hectors, yet to be developed for irrigation. Area covered by surface and ground water irrigation are 854,000 and 206,600 hectors respectively aand representing 80.6% and 19.4% respectively of the total irrigated area.

2.2. OBJECTIVES

- To find out the type of diversion headwork.
- To get familiar with the components from headwork canal outlet.
- To know about the provisions for high folding.
- To gather information about the regulating structures and cross drainage stractures.
- To know about the water losses during conveyance.
- To know about total command area canal design discharge and major water sources.
- To know about the past disasters if any.
- To determine the socio-economic benefits of the project in local and national scale.

2.3. METHODOLOGY

The main methodology we followed for the accomplishment of our objective of the field trip was following the explanations made by the related personnel working on respective irigation projects. Similarly, For the study the brochures and the information boards were used. Photogtaphs of the location werw taken and important point wherw noted. Similarly, the different literatures werw also followed for the relibility of data. In the same way, Internate record where utilized to gather informaton regarding different factors of the project.

2.4. STUDY AREA

- ❖ Bagmati Irigatio Project (BIP)

3. INTRODUCTION BAGMATI IRRIGATION PROJECT

Agricultural is vital for rural employment. Nepal has planned to increase its agricultural production at a rapid rate through irrigation development. This also needed continuous performance evaluation for the effective utilization of the resources. BIP also required frequent performance evaluation, which is essential. It would be achieved quickly through RAP. A RAP quickly evaluates an irrigation project to get idea of what type of modernization is needed. The RAP includes external and internal indicators.

Bagmati Irrigation Project (BIP) is Agency Managed Irrigation System (AMIS) with the command of 37000 ha in first phase out of which 14000 ha in Sarlahi district of Janakpur Zone and 23000 ha in Rauthat district of Narayani Zone. Bagmati River is perennial. The project started as Sunkoshi Terai Project during 1978/79 with financial support receives from UNDP, DELF Relief Fund (Japan) and presently Saudi Development Fund. Canal with structures to irrigate about 30000.0 ha (command area development) of arable land is going to complete in near future. It is proposed to irrigate 122000 ha in Sarlahi, Bara, Rauthat, Mahottari and Dhanusha district in the end of second phase. Total irrigable area of country is 1766000 ha out of which BIP accounts 2.1 % in first phase and 6.9 % in second phase of total national irrigable area. Water management can help improving production and make the country self-sufficient in food production. Rapid Appraisal process (RAP) is a quick methodology to evaluate an irrigation project to get idea of what type of modernization is needed. Any irrigation project needed continuous performance evaluation for the effective utilization of the resources and it is applicable for BIP.

32 WUA formed up to till now in those areas where command area development works have been completed. They are doing repair, maintenance and water management work in tertiary canal and are in close contact with project for other canal system maintenance and water management work.

Water Management in the face of the growing water scarcity and increasing population in order to continue on the path of the socio- economic development needs effective institutional arrangement and right allocation of water to users. Performance of irrigated agriculture is improved by reliable supply of water.

The irrigation systems to be modernized support rice cultivation as the main crop during the dry season. Modernizing the irrigation and drainage systems will result in water savings, improved water productivity and diversify the crop. There is wide range of levels of irrigation service and the nature of the service may vary from highly flexible service to inflexible service up to farm level. It is important to emphasize that an irrigation project is a network of many hydraulic delivery layers and each layer provides service to next lower level. The level of the service may be different at each layer. It is therefore important to identify what existing level of service is and what is expectation. A good water delivery system is expected to be flexible characterized by frequency; flow rate; duration; equity reliability and timeliness. Equity is the prime goal of any Farmers Managed Irrigation System in Nepal.

3.1. <u>Description of the Bagmati Irrigation Project</u>

Bagmati Irrigation Project is one of the national priority irrigation projects in Nepal. It is a large-scale project. It lies in the Sarlahi district of Janakpur zone with a catchments area of 2720 sq. km. It irrigates 14000 ha in Sarlahi district of Janakpur zone and 23000 ha in Rauthat district of Narayani zone thus have total command area of 37000 ha in first phase. It is

proposed to irrigate 122000 ha in Sarlahi, Bara, Rauthat, Mahottari and Dhanusha district in the end of second phase. The main aim of this project is to improve living standard of farmers, check trans migration and provide work opportunity in the command.

Bagmati River is a perennial river, originating from Himalayas. Barrage is located in the upstream of Bagmati River from East-West highway having 403.5 m length. It has 17.1 km eastern main canal with 64.4 cumecs discharge capacity. This has three branch canals viz Manpur, Gadhaiya and Laxmipur irrigating 14000 ha command area. It has 28.2 km Western Main Canal with three branch canals viz Bhalohiya, Bahuyari and Baghi irrigating 23000 ha command are.

3.2. Location of Bagmati irrigation project

The project area lies between longitudes 85017′ to 85036′ East and latitude 26046′ to 2706′ North, and Comprises of land in the Sarlahi district of Janakpur Zone and Rauthat district of Narayani Zone of the Central Development Region. The command area of the project lies in the south of East-West high way and north is the Churia hills. It is a flat plain with ground elevations varying typically, between 60m above mean sea level on the southern border with India to 130m at the boundary of Siwalik, and is called the Terai. The major rivers within the project area are Lal Bakeya, Lamaha, Chandi, Bagmati, Lakhandei and Jhim. The source of water for irrigation supply is Bagmati River.

Figure 1: Location of Bagmati Irrigation Project

3.3. Climate and Hydrology of Bagmati Irrigation Project

Climatic conditions in the project area are dominated by monsoon. Averages annual rainfall is 1440 mm. There is considerable year-to-year variation in precipitation. The wet season extends over the period of four months from June to September. Mean annual temperature is 250C ranging from 160C in January to 300C in May and June. Relative humidity ranges from 54% in April to 83% in August. Agro-climatically these conditions are favorable for exploitation of agricultural potential. Discharge record of the rivers in the project area is available only at Karmaiya station in the Bagmati River. The average annual discharge for the period of 1965-75 at Karmaiya, which has a catchments area of 2700 km2, is estimated 177m3/sec with a minimum of 129m3/sec and maximum of 216m3/sec. Over 80% of run off occurs in the four months from June to September. The mean monthly discharge fluctuates from 586m3/sec in July to14.8m3/sec in April. In addition to river water, shallow and deep ground water is available in the project area.

3.4. **Water User's Association**

Water User's Association (WUA) plays a vital role in irrigation development and management. User's association registration started from 1998 in the area where command area work has been completed in the tertiary level canal. Project is planning to register up to main canal level and hand over the system those who are capable to regulate, operate and maintained the system. Registration is under the process.

Bagmati Irrigation Project (BIP) is under construction phase. Command area development work has been completed on the 30000 ha out of 37000 ha command area and 7000ha has been proposed for construction. 28 water users association registered during 1997-98. There is only one association organizer recruited in the office. Which is not sufficient to look after all. Project officials carry out major construction work. Maintenance work is carried out through WUA. During 2004 devastating flood damaged the canal network in July, at the same time drought occurs long time during the rice growing period. They are forced to regulate water through canal for their betterment. They started to register more and more water users association according to irrigation policy 2003. They were given training and innovative program through BIP. They were familiar with rule, regulation and policy. Most important fact is that they feel scare water will be available only especially in the tail end of canal through rotation system in the presence of effective WUA. Small economic incentive, conscience with rule and regulation to cope up with drought situation, they started to registered the WUA with active participation of BIP. During July 2005, 4 WUA registered in BIP and around 20 number of WUA are in process of registration. Total number of registered WUA becomes 32. Their active participation improved the agricultural performance of the BIP by improving the defunct network of canal system.

3.5. Summary of Headwork: Bagmati Irrigation Project

Location: Karmaiya, Sarlahi

Start-Completion: June 2008-June 2010

District Faciliated: Sarlahi by eastern canal head and Rautahat by western canal head

Weir/Barriage portion: Barriage type

Major Components: Dividewall (eastern and western), Fishladder (Eastern and Western), Barriage gates(15 for eastern and 15 for western), Canal Head Regulator(7 on eastern and 5 on western).

4. Components of head regulator

- **Guide banks Plan view of Headwork, BIP**
  - On both side of the river
  - More natural than man made
  - Flood bypass is constructed on the right bank (flow direction)
- **Divide wall/fishladder**
  - One eastern and one on Western
  - Extends around 20m upstream and 20m downstream
  - Fishladder attached to both divide wall on downstream side
  - High silting on fish ladder has disruptted its work
- **Barriage Portion**
  - 30 gates are built (15 allocated for east and 15 for west)
  - Gates sized 9*3 m and weigh around 10 ton each
  - Gates are closed and open by electric lifting machanism, also by manual pully which is hard and takes lots of time.
- **Undersulice portion**
  - On eastern and western side
  - Bed level below 1m of barriage portion
  - 3 gates on each side - Gates sized 9*4 m.
- **Canal Head Regulator**

- 7 on the eastern side and 5 on the western side

5. Detail briefing of BIP

The details of Bagmati Irrigation Project's Barrage is,

Design Discharge	8000 Cumecs
By Pass Channel	2500 Cumecs
Total	10,500 Cumecs

Eastern Head Regulator	
Maximum Discharge	64.4 Cumecs
Number of Gate	7 (4M * 2M)

Length	403.50 M
Duty	1.3 Ltr/Sec
No of Gate	30 (9M * 3M)
Number of Under-Sluice	6 (9M * 4M)
Number of Fish Ladder	2 (1.5M * 4M)

Western Head Regulator	
Maximum Discharge	48.4 Cumecs
Number of Gate	5 (4M * 2M)

The major components of irrigation systems are described below.

6. Barrage and Weir

WEIR: It is an impervious barrier which is constructed across a river to raise the water level on the upstream side is known as a weir. Here, the water level is raised up to the required height and the surplus water is allowed to flow over the weir. Generally, it is constructed across an inundation river.

BARRAGE: When adjustable gates are installed over a weir to maintain the water surface at different levels at different times is known as a barrage. The water level is adjusted by operating the gates or shutters. The gates are placed at different tiers and these are operated by cables from the cabin. The gates are supported on piers at both ends. The distance between the pier to pier is known as Bay.

7. Head-works

Hydraulic structures which supply water to the off taking canal is called head-works. It can also be defined as the structures made to control desired water flow safely to the desired direction at the water source. It serves the following functions.

- It raises the water level in the river so that the commanded area can be increased.
- It regulates the intake of water into canal.
- It controls the silt entry into the canal.
- It reduces fluctuations in the level of supply in river.

The head-works should safely dispose excess flood water at downstream. There are two types of head-works.

a) **Storage Head-works**
When dam is constructed across a river to form a storage reservoir, it is known as storage headworks. It stores the water during the period of excess supplies in the river and releases it when demand overtakes the available supplies.

b) **Diversion Head-works**
When a weir or barrage is constructed across a river to raise the water level and to divert the water to the canal, then it is known as diversion headworks. Diversion headworks are common for irrigation projects.

8. Main barrage portion

This is the main body of the barrage normally of R.C.C. slabs which support the steel gates. In cross-section it consists of

- U/S concrete floor to lengthen the path of sewage and to protect the middle portion where the piers, gates and bridge are located.
- A crest at the required height above the floor on which the gates rest in their closed position.
- U/S glacis having the necessary slope to join the u/s floor level to highest point, the crest.
- D/S glacis of suitable shape & slope. This joins the crest to the d/s floor level (which may be at river bed level or below). The hydraulic jump forms on the glacis since it is more stable than on the horizontal floor and this reduces the length of concrete work requires on d/s.
- D/S floor is built of concrete and is constructed so as to contain the hydraulic jump. Thus, it takes care of turbulence which would otherwise cause erosion. It is also provided with friction blocks of suitable and at distances determined by hydraulic model experiments in order to increase friction and destroy residual K.E.

9. Guide bank

Guide Bank are earthen embankments with stone pitching in the slopes facing water, to guide the river through the barrage, these river training works are provided for rivers flowing in planes, upstream and downstream of the hydraulic structures or bridges built on the river. Guide banks guide the river water flow through the barrage.

10. River training works

It includes guide banks, marginal bunds, spurs etc. Functions are as follows,

- To provide and non-tortuous approach to weir.
- To prevent the river from out-flanking the weir.
- To prevent additional area to be submerged due to afflux.
- To prevent erosion of the river banks (protective works).

11. Marginal bunds

Marginal bunds are flood embankments in continuation of guide banks designed to contain the floods within the flood plain of the river. Both height and length vary according to back water effect caused by the barrage. They are not provided with stone pitching and fully cover the back- water length. Marginal bunds are also called as ‘Spurs’.

12. Canal head regulator

These are the structure constructed at the head (off take) of the canal adjacent to the under sluices. Its function is;

- To admit water into the off taking canal.
- To regulate the supplies into the canal.
- To indicate the discharge passed into the canal from design discharge formula and observed head of water on the crest.
- To control the silt entry into the canal.
- During heavy floods, it should be closed otherwise high silt quantity will leave to the canal.

13. Divide wall

It is a long wall constructed at right angle to the weir axis. It is extended up to the upstream end of the canal head regulator. In case of one canal off-taking from each bank of the river, one divide-wall is provided on front of each of the head regulators of the off takes. Similarly, on the d/s side it should extend to cover the hydraulic hump and the resulting turbulence. The main functions are as follows;

- To generate a parallel flow and thereby avoid damage to the flexible protection area of the under-sluice portion.
- To keep the cross-section, if any, away from the canal.
- To serve as a trap for coarser bed material.

- To serve as a side-wall of the fish ladder.
- To separate canal head regulator from main weir.

14. Fish ladder

It is a narrow trough opening along the divide wall towards weir side provided with baffles (screen to control the flow of the liquid, sand etc.), so as to cut down the velocity of flowing water from u/s to d/s. location of fish ladder adjacent to divide wall is preferred because there is always some water in the river d/s of the under sluice only. It may be built within the divide wall. A fish ladder built along the divide wall is a device designed to allow the fish to negotiate the artificial barrier in either direction. In the fish ladder, the optimum velocity is (6-8) ft/sec. Fish move from u/s to d/s in search of relatively warm water in the beginning of water and return u/s for clear water before the onset of monsoon.

15. Under sluice

Under sluice is the opening at low level in the part of barrage which is adjacent to the off takes. These openings are controlled by gates. They form the d/s end of the still ponds bounded on two sides of divide-wall and canal head regulator. They perform the following functions.

- To control silt entry into the canal.
- To protect d/s floor from hydraulic jump.
- To lower the highest flood level.
- To scour the silt deposits in the pockets periodically.
- To maintain a clear and well-defined river channel approaching the canal head-regulator.

16. Inverted filter

An inverted filter is provided between the d/s sheet piles and the flexible protection. It typically consists of 6" sand, 9'' coarse sand and 9" gravel. The filter material may vary with the size of the particles forming river bed. It is protected by placing concrete blocks of sufficient weight and size, over it. Slits are left b/w the blocks to allow the water to escape. The length of the filter should be (2 × d/s depth of sheet pile). It performs following functions;

- It checks the escape of fine soil particles in the seepage water.
- In the case of scour, it provides adequate cover for the d/s sheet piles against the steepening of exit gradient.

17. Shutters or gates

Barrage are provided either with shutters or counter balanced gates to maintain pond level. A shuttered weir is relatively cheaper but locks in speed. Better control is possible in a gated barrage. Their function is;

- To maintain pond level.
- To raise the water level during low supplies.

In case of higher floods, shutters are dropped down and overflow takes place while in case of gated weir, gates are raised during floods.

18. Silt Excluder

Silt Excluder is a structure constructed in the bed of river, u/s of head regulator to attack the river bed water and divert the same into the d/s of the river. Its main function is to prevent the entry of silt into the canal.

19. Silt Ejectors

They are also called silt extractor and are provided to extract silt from canal water after the silted water has travelled a certain distance in the off taking canal. These works are therefore constructed on the bed of the canal and a little distance d/s from the head regulator. They consist of curved tunnels located across the canal which starts along the axis of canal and turn towards the bank into the escape channel. The silted water is discharged into the d/s side of river from barrage.

20. Canal Outlet

An outlet is a hydraulic structure convening irrigation water from a state-owned channel i.e. (distributary, minor etc.) to a privately owned water course. It is basically the last hydraulic structure at the end of irrigation systems. Outlets may be classified as;

- The non-Modular Outlet.
- Semi-Modular / Flexible Outlet.
- Modular/Rigid Outlet.

21. Cross Drainage Structures

There are three types of cross drainage structures.

Type 1 – Irrigation Canal passes over the drainage

- Aqueduct – When the H.F.L. of the drain is sufficiently below the bottom of canal, water flows under the action of gravity, such structure is known as aqueduct.
- Siphon Aqueduct – When H.F.L. of the drain is much higher above the canal bed and water runs under siphonic action through the aqueduct barrel, such structure is called siphon aqueduct.

Type 2 – Drainage passes over the irrigation canal

- Super-passage – The hydraulic structures in which the drainage is passing over the irrigation canal is known as super passage.
- Siphon Super-Passage - The hydraulic structure in which the drainage is taken over the irrigation canal, but the canal water passes below the drainage under siphonic action is known as siphon super-passage.

Type 3 – Drainage and canal intersect at same level

- Level Crossing - When the beds of the drainage and canal are practically at the same level, then a hydraulic structure is constructed which is known as level crossing
- Inlet and Outlet – In the crossing of small drainage with small canal, no hydraulic structures are constructed. Simple openings are provided for the flow of water in respective direction. This arrangement is known as inlet and outlet.

Some Pictures of BIP