Design Lab # 2

Planning & Design of Surface Irrigation system for a given area:

Part 1:

1. **Various steps for planning the irrigation system for an area**
2. **Estimation of Crop Water requirement**

- **Area identification, GCA, CCA, NCCA.**
- **Alignment of canals, distributaries and water-courses**
- **Deciding the cropping pattern.**
- **Important definitions**
- **Estimation of crop water requirements.**

Area Identification:

Gross Command Area (GCA) is the area which is bounded within irrigation boundary of a project, which can be economically irrigated without considering the limitation of the quantity of irrigation water. It also includes the area which cannot be cultivated e.g villages, roads, utility etc.

It is total area used for design consideration. This may be cultivated or non cultivated area depending upon the condition and topography.

Culturable Command Area (CCA) is the effective area which is culturable or the area that is cultivated out of total command area.

Non Culturable Command Area (NCCA) is the area which is not cultivated.

CCA=GCA-Non Culturable Command Area

Chak Bandi is to divide the whole CCA into command area of each outlet.

Alignment of Irrigation Channels:

The alignment of irrigation channels can be divided into two parts, namely

(a) Alignment of canals and distributory.

(b) Alignment of water course.

(a) ***Alignment of canals and distributory***

i). The canals and distributaries should be aligned in such a manner that the entire tract (land) should be irrigated by flow-irrigation. In order to achieve this objective and also to cut down cost in construction channels should be aligned along ridges. If this fact is overlooked the channel will run through filling which will not only entitle higher cost but will also jeopardize the area with water logging.

ii). Unless otherwise specified by higher authority, the contour plan with scale 2" to a mile and having contour at 5' interval should be used for studying the alignment of canals and distributory. The contour plan should be studied thoroughly and different proposals should be marked on plan and their merits and demerits should be weighted. The most economical and practical should be adopted.

iii). Care should, however be taken that the irrigation channel do not cross the drainage system of the area.

iv). Obstacles, such as roads, towns, railway lines, canals etc should be avoided.

v). An irrigation channel should not as far as possible cut an area which is irrigated by wells.

vi). The main as well as branch canals are carrier canals, and so no direct irrigation should be done from them.

vii). The main channel should be split into moderate sized branch canals and the splitting point should be so located that maximum area is irrigated economically.

viii). The distributaries should be so aligned that length of a water course taking off from it should in no case exceed **two miles**.

ix). Effort should be made to keep the channel straight. When it is not possible, the minimum radii of curves should be kept as follows;

Capacity of Channel (Cusecs)	Minimum Radii of curves (feet)
Over-3000	5000

3000-1000	3000
1000-500	2000
500-100	1000
100-10	500
Less than 10	300

x). As maintenance cost of a distributory is inversely proportional to its discharge, large sized distributaries are better than small ones.

(b). ***Alignment of water course***

i). The alignment of a water course unless otherwise directed by the higher authorities, should be studied on a plans having a scale of 8" to a mile and showing spot levels at every corner of 500 ft.

ii). A water course should be minimum in length.

iii). As far as possible a water course should be aligned within one square. i.e 25 acres **(990x1100), 1 hectare = 2.47 acres**

iv). In order to reduce absorption losses, a water course should irrigate on its both sides.

v). Ordinarily only one **nakka** is sanctioned for each watercourse. But where the configuration of ground does not admit of one nakka, a second may be provided.

Deciding the cropping pattern

Cropping pattern means how many crops and how much area for a crop is being cultivated.

Croping Intensity/cultivation intensity is the %age of area of a particular crop with respect CCA.

Factors Effecting Cropping Pattern:

Climate
Soil characteristics
Hydrology
Water allowance
Crop water requirements
Intensity of cropping and irrigation
Farmers's requirements for food, fodder clothes etc.

Crop Water Requirement:

It is the total amount of water required by the crop in a given period of time for normal growth, under field conditions. It includes evaporation and other unavoidable losses. It is normally expressed in terms of depth of water and associated with the area of crop.

Crop water requirement = Consumptive use + Seepage Losses in the field + Others (water need for land preparation)

Consumptive Use**:** It is the amount of water required by a crop for its vegetated growth to evapotranspiration and building of plant tissues plus evaporation from soils and intercepted precipitation. It is expressed in terms of depth of water.

Consumptive use varies with temperature, humidity, wind speed, topography, sunlight hours, method of irrigation, moisture availability.

Estimation of Consumptive Use:

1. Direct method
2. Pan evaporation method
3. Empirical method

Factors influencing crop water requirements

i. Effect of Major Climatic Factors on Crop Water Needs

Climatic factor	**Crop water need**	
	High	**Low**
Sunshine	Sunny (no clouds)	cloudy (no sun)
Temperature	hot	cool
Humidity	low (dry)	high (humid)
Wind speed	windy	little wind

ii. Influence of crop type on crop water needs

The influence of the crop type on the crop water need is important in two ways.

a. The crop type has an influence on the daily water needs of a fully grown crop; i.e. the peak daily water needs of a fully developed maize crop will need more water per day than a fully developed crop of onions.

b. The crop type has an influence on the duration of the total growing season of the crop. There are short duration crops, e.g. peas, with a duration of the total growing season of 90-100 days and longer duration crops, e.g. melons, with a duration of the total growing season of 120-160 days. There are, of course, also perennial crops that are in the field for many years, such as fruit trees.

Conveyance Losses: Take place from barrage to the field (outlet). So design should be according to requirement of water plus losses.

Major loss of water in an irrigation channel is due to absorption, seepage or percolation and evaporation. In earthen channels losses due to seepage are much more than the losses due to evaporation. The absorption losses depend upon following:

- Type of soil
- Subsoil water
- Age of canal
- Position of FSL w.r.t to NSL
- Amount of Silt carried by canal
- Wetted perimeter

Crop Period: It is the time normally in days that a crop takes from the instance of its sowing to harvesting.

Base Period: is the time in days between the first watering and last watering to the crops before harvesting.

Note: Base Period is normally less than the crop period depending upon the type of crop.

Delta of a crop: Total depth of water required by the crop in unit area during base period. In other words it is the total depth of water required for maturing the crop.

Volume = Depth x Area.

Now to get the total amount of water for crops (i.e water for Kharif and Rabi crops) add water for each crop individually as

Q=Volume/Time

Rabi Season (October to March):

Crop	**Consumptive Use (cm)**
Wheat	37
Gram	30

Barley	30
Potato	60-90
Sugar cane	90
Fodder	40
Oil seed	45
Berseen	70

Kharif Season (April to September):

Crop	Consumptive Use (cm)
Cotton	25-40
Maize	45
Rice	125-150
Sugar Cane	90

Indicative Values of the Total Growing Period

Crop	Total growing period (days)	Crop	Total growing period (days)
Barley/Oats/ Wheat	120-150	Millet	105-140
Bean, green	75-90	Onion, green	70-95
Citrus	240-365	Pepper	120-210
Cotton	180-195	Rice	90-150
Grain/small	150-165	Sorghum	120-130
Lentil	150-170	Soybean	135-150
Maize, sweet	80-110	Squash	95-120
grain	125-180	Sunflower	125-130

Water Availability

Duty of a Crop: It is the area irrigated in hectors by one cumecs or area irrigated in acres by one cusecs.

Full Supply Factor: From the statistical records for different projects in operation, duty is determined. The Base periods are Rabi (Winter Crop) and Kharif (Summer Crop). By comparing the tract (land) to be irrigated with those already under irrigation and by studying other relevant factors which affect the duty, a fair guess of it for new project is made. The term duty is only used for existing or running projects, but in a proposed project it is known as full supply factor.

Intensity of Irrigation: percentage of culturable area irrigated during a base period or annually.

Water Allowance: This is the amount or discharge in cusec required to irrigate 1000 Acres of an area.

$$Water\ Allowance = \Sigma Q x 1000/CCA$$

Discharge Statement: This gives the information of discharge at every point/section of the canal.

Water Conveyance Efficiency: It is the ratio of the water delivered to the farmer by conveyance system to the water introduced into the canal at source.

Calculations for Required Discharge

Gross Command Area = Given

Non Culturable Command Area = about 10-15% of GCA (wrong assumption)

Culturable Command Area =

Discharge for Rabi:

Crop	Crop Period (Days)	Intensity %age	Area (Acre)	Full supply factor/delta (inch)	Volume (Acre-ft)	Q (cusec)

Wheat	**150**	**40**		**14**		

ΣQr

<u>Discharge for Kharif:</u>

Crop	**Crop Period**	**Intensity %age**	**Area (Acre)**	**Full supply factor /Delta (inch)**	**Volume (Acre-ft)**	**Q (cusec)**

ΣQk

Design Discharge= larger of ΣQr or ΣQk

CCA in Acres = ___________ Acres

Water Allowance = ΣQx1000/CCA

Assume Required Discharge at outlet

Q_{outlet} =2-3 cusecs.

Therefore; Command area of outlet = WAxArea/1000

Now divide CCA in according to CA of outlet.