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PLANNING AND DESIGN OF PIPE DISTRIBUTION NETWORK FOR IRRIGATION

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ABSTRACT
As per international standards India belong to water stress zone with threats of climate change may further aggravate the problem. By the year 2050, with projected population of the order of 1.6 Billion, the water availability will further reduce to 1140 cum nearing to water scarce situation. India as a country has to adopt itself to this changed scenario. In order to make attempts to minime this problem this research contributes through its approach of planning and design of pipe distribution network used for the irrigation purpose.

INTRODUCTION
Historically Irrigation development in the country has been undertaken as Canal Distribution Network emanating from rivers, dams and reservoirs for the purpose of carrying water mostly through gravity up to outlets and from outlets to agricultural field through water courses or field channels. In earlier times canals were unlined; later on these unlined canals have been improved by lining to increase their water carrying efficiency which led to extend water deliveries to additional fields which had not been irrigated previously. Canals are designed hydraulically to provide the most efficient cross section for the transportation of irrigation water. There is no further scope in improving the efficiency of the hydraulically most efficient canals section with most efficient lining. Therefore the overall efficiency that can be achieved by canal conveyance and distribution has reached the upper limit which is about 30-40%.
With the increasingly greater demand on limited water supplies in many parts of country, there is an urgent need for its efficient utilization by reducing losses at various reaches in the irrigation system. Replacement of existing canals with pipe lines or new schemes with pipe lines wherever feasible in order to improve irrigation efficiency or to further extend the area of irrigated agriculture is the need of the hour. Field application of water through micro irrigation methods improves overall efficiency of the project to a great extent. Piped irrigation can be accomplished many a times through gravity and/or use of pumps to lift the water into the distribution network.
Piped Irrigation System provides one of such options which if implemented properly can curtail irrigation water demand without compromising with net irrigation requirement (NIR) but by improving the water use efficiency. The estimated overall efficiency with piped irrigation network is of the order of 70-80%.

PIPED IRRIGATION NETWORK (PIN)
A Piped Irrigation Network (PIN) is a network of installation consisting of pipes, fittings such as valves, pumps (if necessary) and other devices properly designed and installed to supply water under pressure from the source of the water to the irrigable area.
For surface irrigation method, where large heads are not required, the underground pipe line system is used which is essentially a low pressure system, also known as ‘open or semi closed’ system. This system is open to atmosphere and where the operating pressure seldom exceeds 5m to 6m. The available level differences of falling topography provide the operating head for the system under gravity for the low pressure flows.
Where large heads are required, underground pipe line system is used which is essentially a high pressure system, also known as ‘closed’ system. This system is not open to atmosphere and where the operating pressure exceeds 10m for drip and 20m for sprinklers. Usually gravity head is not sufficient to create such a high pressure; therefore, pumps are used for this kind of system.

ADVANTAGES OF PIN OVER CDN

i) As most of a piped distribution system underground, right of way problems are significantly reduced, allowing more direct and rational layouts to be chosen. Because outlet location is not limited by topography, pipe systems are better able to accommodate existing patterns of land ownership with the minimum of disruption compared with new irrigation development using CDN.
ii) Cross Drainage and Cross Masonry (Communication) structures can be omitted or minimized.
iii) Irrigation works become obstacles in the way of free drainage of water during rainy season and thus results in submerging standing crops and even villages.
iv) No damage due to heavy rainfall or flood during monsoon.
v) More Suitable option for flood prone area.
vi) No hindrance in movement to the farmers and farm equipment's.
vii) Increase in CCA as compared to canals, as the water losses are negligible and acquired land for canal network can also be used for cultivation as PIN is under ground.
viii) Better option for undulating fields.
ix) Because of shorter transit times for water from source to field, lower conveyance losses and the smaller volumes of water in the conveyance system, pipe systems can deliver a supply which is more flexible in both duration and timing, in a way not possible CDN, so enabling intensification and diversification into higher value crops.
x) Less execution time for PIN as compared to CDN.
xi) The important targets of the modernization of irrigation schemes and digital management will be achieved when water is delivered through PIN.
xii) In case of canals, the marshes and the ponds caused by excessive seepage, in course of time become the colonies of the mosquito, which gives rise to vector borne diseases and this can be minimized by adopting PIN.
xiii) Increase in project efficiency of the PIN is about 20% as compared to CDN.

DISADVANTAGES OF PIN

i) Initial cost is generally higher as compared to CDN.
ii) PIN may not suitable if the irrigation water contains large amount of sediments. Desilting arrangement would be necessary in such cases.

APPLICATION OF PIN

The Pipe Irrigation Network systems especially are to be preferred over CDN alternatives in the following situations:
(i) Where water is valuable both, in terms of the crops which can be grown and limited availability as evidenced by low reservoir capacity or restrictive controls on water abstraction from river or groundwater sources,
(ii) Where poorly cohesive soils would result in high seepage losses from open canals,
(iii) Where irrigable land cannot be reached by an open canal system due to high ground levels.

NECESSITY OF PDN

PDN is increasingly felt necessary to improve Overall Project Efficiency (OPE) of gravity irrigation systems. Conventional gravity irrigation systems are basically open channel systems. Their design OPE itself is obviously low and it ranges between 41 to 48% only. Actual OPE, it is needless to say, is only 20-35% in most of the projects due to many difficulties and constraints. PDN, if introduced, may substantially improve both design and actual OPE. This is one of the main reasons why PDN has become a necessity.

PIPED IRRIGATION NETWORK (PIN) PLANNING

Piped irrigation network is a network installation consisting of pipes, fittings and other devices properly designed and installed to supply water under pressure from the source of the water to the irrigable area. Pipelines also permit the conveyance of water uphill against the normal slope of the land and, unlike open channels, can be installed on non-uniform grades. The use of buried pipe allows the most direct routes from

the water source to fields, and minimizes the loss of productive land (since crops can be planted on the fields above the pipelines). An analogy between the Canal Distribution

PIPE IRRIGATION NETWORK (PIN)

The planning and layout of PIN unlike CDN is not controlled by the command area to be irrigated and the source of supply. The layout of main lines and branches is generally fixed on the consideration of economy. For the layout of minors and distributaries, points of off take may be suitably selected but their layout is more or less governed by the blocks of areas to be irrigated taking into consideration watersheds and drainages. The main lines and branches are feeder lines for distributaries and generally no irrigation is done directly from them. Irrigation outlets are provided on distributaries or minors off taking from distributaries.

OBJECTIVE OF PIPE IRRIGATION NETWORK

Pipe irrigation system provides one of such option which if implemented properly can fulfil irrigation water demand without compromising with net irrigation requirement

i. To increase overall efficiency of irrigation project compare to cdn
ii. To avoid evaporation rate compare to cdn
iii. To increase greater demand on limited water supply

LITERATURE REVIEW

Mr. Sandesh B. Kulavmode, Dr.S.S.Valunjkar2017 observed that almost 50 % of water is lost during the storage and distribution. Also there are many disadvantages of the conventional system of irrigation. Their design overall project efficiency (OPE) of the conventional system is obliviously low and ranges between 41 to 48 % only. They have discussed about the magical improvement in the OPE of an irrigation project by adopting PDN. The paper compares the percentage increase in efficiency of the project and other parameters for an illustrated project of Nagthana-2 in Amravati District of Maharashtra.

M. Satpute, P. V. Khandve, M. L. Gulhane 2016 0bserved that overall efficiency of irrigation projects is around 41 – 48 %, it means that the average 50 % of water get lost. and implied that benefit of capital cost incurred on the traditional open channel system for irrigation purpose is less than 50 %. Also they observed that at many places, extra water is supplied to agriculture field due to bad practice of irrigation, it create the problem of water logging and thereby reducing the fertility of land. And to save the precious water storage, and to utilize the maximum efficiency of irrigation project, it is necessary to overcome the problems in the traditional practice of irrigation through pipe distribution network (PDN) for gravity irrigation systems.

Chandrashekhar Bhagat, Ashwini Mirajkar 2017studied Irrigation network system for existing irrigation projects is a branching type. They observed that Loop system is more reliable as alternate routes are available for conveying water to the demand nodes. But it is costlier than branch type system. Reliability is preferred to economy. Therefore branch systems are mostly used in irrigation network system. The aim of the present work is to get the optimal design for given irrigation water distribution pipe network. The main objective of the study is to minimize the overall cost of the piped irrigation network without violating any design constraints

Jay Mehare, Rushabh Gore studied and concluded that Irrigation project improves by the PDN system as it is a one of the best way to increase efficiency. The conventional CDN have less water use efficiency i.e. 25% to 40%, in other hand gravity based PDN make improvement i.e. overall water use efficiency to 70% to 80%. As PDN system saves water than CDN system. It is useful where there is land cost is high Also where the channel passes through the deep cut of black cotton soil and it is suitable where the modern technique like sprinkler as well as drip irrigation is use.

Santosh Patil S.D. Talegaonkar P.T. Nimbalkar discussedabout various available equations for calculation of the head loss in pipe. In this project the PDN system is designed with help of Modified Hazen William Formula.And concluded that this gap can be reduced by using irrigation system which has highest water use efficiency. Therefore use of pipe distribution network (PDN) system is inevitable

METHODOLOGY

Ter is a Village in Osmanabad Taluka in Osmanabad District of Maharashtra State, India. It belongs to Marathwada region. It belongs to Aurangabad Division. It is located 19 KM towards North from District headquarters Osmanabad. 12 KM from Osmanabad.

Ter, settled along both the banks of the Terna is a historically important village inOsmanabad district lying some 32.19 km (20 miles) from the tehsils headquarters. Its antiquity can be traced as far back as the Puranas wherein it is referred to as Satyapuri and in the ancient period of our history as Tagarnagar. 18° 19′ 16.67″ N, 76° 7′ 58.7″ E (18.321299, 76.132971. It is a large village located in Osmanabad Taluka of Osmanabad district, Maharashtra with total 2645 families residing. The Ter village has population of 12479 of which 6481 are males while 5998 are females as per population Census 2011. In Ter village population of children with age 0-6 is 1531 which makes up 12.27 % of total population of village. Average Sex Ratio of Ter village is 925 which is lower than Maharashtra state average of 929. Child Sex Ratio for the Ter as per census is 840, lower than Maharashtra average of 894.

Ter village has lower literacy rate compared to Maharashtra. In 2011, literacy rate of Ter village was 77.01 % compared to 82.34 % of Maharashtra. In Ter Male literacy stands at 83.01 % while female literacy rate was 70.62 %. As per constitution of India and PanchyatiRaaj Act, Ter village is administrated by Sarpanch (Head of Village) who is elected representative of village. Our website, don't have information about schools and hospital in Ter village.

OBJECTIVE OF STUDY AREA

i. The Present Study Aims at understanding the impact of pipe distribution network
ii. To Study pipe distribution network of ter village.
iii. To increase over all efficiency of irrigation project .
iv. To avoid evaporation

REQUIREMENTS FOR PDN

i. Water Users Association at minor level / branch level must be formed prior to the beginning of construction of PDN.
ii. The project level association should also be formed.
iii. The WUA members should be actively involved in the execution of PDN.
iv. The volume of water will be supplied in the proportion of CCA of an individual farmer.
v. There will be full freedom to the beneficiary farmers to grow crops as per their choice.
vi. The water need to be conveyed through HDPE portable pipes from chak head to the farm head to save conveyance losses.
vii. Straight ridges & furrows, borders and basin irrigation methods will be used as per the type of crop grown.

DATA REQUIRED FOR PIN PLANNING

i) Topographical map of the area
ii) Subsurface data
iii) Texture and salt component of the soil
iv) Soil characteristics including mechanical properties and shear parameters
v) Permeability of the soil in relation to seepage losses
vi) Rainfall data
vii) Water availability
viii) Subsoil water level in the area and quality of the underground water
ix) Possibility of water logging and salination
x) Availability of suitable construction material
xi) Existing drainage and drainage facilities
xii) Existing crop pattern
xiii) Existing communication and transportation facilities
xiv) Socio economic study and agro economic survey of the project area

xv) Adequate investigation should be carried out to collect the data given by digging trial Pits and bore holes, where necessary, to ascertain the nature of soil encountered along different alternative alignments.

RESULT AND DISSCUSSION

Site Selection

While selecting o the sites, preference was given to

1. Area where Rabi and Kharifcrops are grown through canal irrigation only,as deficiency of water generally occurs in Rabi season. Kharifseason is amonsoon season and sufficient amount of water is available for irrigation.
2. Cooperation of the scheme population is very important for planning and successful working of irrigation system.

Detail of study area

Terna dam
FRL : 644.20
Irrigiation water use : 6.932 cum
G.C.A:2412
C.C.A:2235
I.C.A :1665
Design data sample for :940m
Calculated data for single minor
G.C.A:93.44
C.C.A:74.72
I.C.A :46.70

Discharge Calculation

C.C.A = 74.72 ha.
I.C.A = 46.7 ha.

As approved cropping pattern & as per calculation derived from Modified Penman method the maximum crop water requirnment for 1000 ha. of ICA is in second forthnight of august.

= 31.33 Ham
= 0.3133 Mcum
= 313.3 Cum/Ha of ICA

$$= \frac{313.3 \times 1000}{12 \times 24 \times 60 \times 60}$$

= 0.30218 Lps/ha

Discharge at 8630 as per open canal = 1.80E-2 cumecs

Water Calculation

For Link Canal

1) Field application efficency = 65.00%

2) Considering transit losses in main pipeline = 25.00%

Conveyance Efficiency = 75.00%

Overall Efficency = 65.00% x 75.00%

= 48.75% Say 49.00%

For Field efficency = 0.30218 x 48.75%

= 0.147 Lps/ha.

NIR at Canal Head = 0.30218 / 49.00%

GIR at Canal Head 0.61669 Lps/ha

Considering 5 % Losses in Lined Link Canal = 0.0308345 Lps/ha

GIR at Minor Head (Net Discharge) = 0.5858555 Lps/ha

Discharge required for 1 ha ICA. CCA

= 0.5858555 = 0.5858555

1000 1625

= 0.000585855 Cumecs = 0.000360526 Cumecs

ICA of Minor = 46.7 ha. = 74.72 Ha.

Total Discharge required at head for 12 Days rotation = 46.7 x 0.000585855 = 74.72 x 0.000360526

= 0.027 Cumecs = 0.027 Cumecs

Chak Size Calculation

Considering Outlet Discharge 6 LPS

Volume of Water released through Outlet in One day = (6/24/60/60)/1000
= 518.4 Cumec

Considering 12 Days Rotaion Period = 12 x 864 Cum

= 6220.8 Cum

Maximum Size of Chak in Ha (ICA) = 6.2208 / 0.5858555

= 10.618317998 ha. ICA

Proposed Size of Chak in Ha (ICA). = 12 ha. ICA

Chak size proposed for pipe distribution is 5 to 12 Ha.

CONCLUSION

The Modified Hazen William equation is suitable for calculation of head loss due to friction in PDN system. Adoption of underground PDN systems had lead to the reduction in conveyance and distribution losses. The estimation of saving of water due to enhanced efficiencies is carried out. Out of 0.845 cum of saved water, the

drinking water demand can be fulfilled of population of 6758 with 0.626cum and balance 0.219 cum can be used to irrigate 41ha of the area in the villages.

PDN system as it is a one of the best way to increase efficiency. The study concludes that the conventional CDN have less water use efficiency i.e. 25% to 40%, in other hand gravity based PDN make improvement i.e. overall water use efficiency to 70% to 80%. As PDN system saves water than CDN system. It is useful where there is land cost is high Also where the channel passes through the deep cut of black cotton soil and it is suitable where the modern technique like sprinkler as well as drip irrigation is use.

To improve the overall project efficiency of an irrigation project, Pipe distribution Network (PDN) is one of the best solutions which have great perspective. To implement PDN system some guide lines should be followed and to make this system more efficient some new improved guidelines are needed which is possible after implementing and studying project like

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