International Journal of Research
Available at https://edupediapublications.org/journals

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue-01
January 2018

Construction of Reinforced Cement Concrete Pick Up Weir for Storage of Excess Rain Water and To Increase the Ground Water Table

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ABSTRACT:*Now a days in India and all over the world we are facing a huge amount of water scarcity. Water is very essential for human being and as well as for animals to survive. In view of the above problem to overcome it is a good idea for construction of concrete structures in remote areas and forest areas for storage of rain water. So as we can improve the ground water table.*

In this construction techniques we use a variety of innovative methods to bring the weir in to solid structure. it contains Body wall, Upstream and Downstream Aprons in M20, Abutments, Wing walls and Retaining walls in M15 and Stone Revetments on both Upstream and down-stream. In the construction of this structure we use well graded aggregate metal in size 10mm,20mm,40mm and small chips for good mixing. HYSD bars of size 12mm,16mm are used in the construction of body wall which acts as a main component of the whole structure. Admixtures like sp 430 is used in the mix foe good Workability and strength. Toe walls in the upstream side of the structure are raised from deep foundations so as to prevent the structure from uplift pressure of water.

This type of structures are widely adopted now a days in the Rivers, Local Streams, Main canals and waterlogged areas. It is economically feasible and constructional viable.

INTRODUCTION: Irrigation is an artificial application of water to the soil through various systems of tubes, pumps, and sprays. Irrigation is normally used in areas where rainfall is inconsistent or dry conditions or drought is expected.

Irrigation can also be defined as the process of supplying water, in addition to natural precipitation, to field crops, orchards, vineyards, or other cultivated plants. Irrigation water is applied to ensure that the water available in the soil is sufficient to meet crop water needs. The role of irrigation is to improve production and the effectiveness of other inputs. The present site located at Pallikonda is a Village in BheemgalMandal in Nizamabad District of Telangana State, India. It belongs to Telanganaregion . It is located 47 KM towards East from District head quartersNizamabad. 1 KM from Bheemgal. The lowland area that lies between 420 m to 450 m above sea level

The county has a tropical climate and an equatorial rainfall pattern. This climatic condition is influenced by the county's position along the equator and its position on the wind ward side of Nizamabad. It has rainy season, the long rains which occur from june to October and the short rains which occur from mid October to November. The long rains average 607.3 mm while the short rains average 984.9 mm. The amount of rainfall occurs in during east monsoon season and normal rainfall occurs during south west monsoon season. The temperature ranges from a mean of 9^0c in the winter season with high attitude to 40^0c in the summer season.

Neredlavagu Irrigation Scheme is an irrigation scheme in nizamabad district, which is a location in palikonda village , bhemgalmandalNizamabad district of Telangana state.. I identified the problems that the farmers in this scheme were undergoing during my fieldwork attachment.

The proposed scheme is to be designed such that to accommodate a total of about 1,200 farmers and provide for a future expansion of about 20%. The scheme is to get water from neredlavagu. The crops to be grown will be horticultural crops such as Vegetables, soya beans, ground nut, sugar cane. Here most of farmers depend on ground water irrigation.

INTRODUCTION TO WEIR: A weir is a barrier across the horizontal width of a river that alters the flow characteristics of the water and usually results in a change in the height of the river level. There are many designs of weir, but commonly water flows freely over the top of the weir crest before cascading down to a lower level. Weir is defined as a barrier over which the water flows in an open channel. The edge or surface over which the water flows is called the crest. The over flowing sheet of water is the nappe. If the nappe discharges in to the air, the weir has free discharge. If the discharge is partly under water, the weir is submerged or drowned.

Weirs are commonly used to prevent flooding, measure water discharge and help render rivers more navigable by boat. In some

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue-01
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locations the terms demand weir are synonymous, but normally there is a clear distinction made between the structures. A dam is usually specifically designed to impound water behind a wall, whilst a weir is designed to alter the river flow characteristics.

A common distinction between dams and weirs is that water flows over the top (crest) of a weir or underneath it for at least some of its length. Accordingly, the crest of an overflow spillway on a large dam may therefore be referred to as a weir. Weirs can vary in size both horizontally and vertically, with the smallest being only a few inches in height whilst the largest may be hundreds of meters long and many meters tall.

Problem Statement and Problem Analysis: Neredlavagu Irrigation Scheme is an irrigation scheme that is yet to be established in order to help farmers go on with their farming activities even when there is shortage of rains. I came to know about this scheme and identified the problem that they were undergoing during my fieldwork attachment at the Ministry of Water and Irrigation. Due to the recent climate change, irrigation has become of importance to many farmers in most places in Nizamabad.

Farmers have also gained interest in growing crops in and out of seasons whereby it has been a great challenge since there are only two seasons of rainfall:- long rains that come from April to May and short rains that come between the months of October to November. The residents of the area therefore desperately need a water intake structure that will help supply water for their irrigation activities as well as for their domestic use.

They also lack the skills to come up with an intake structure that will last for long, hence the reason why I have decided to design for them an intake structure that will satisfy their needs. In most cases, farmers use sacks filled with soil to divert water from a river. This kind of a structure is not effective and in most cases will fail when the river swells, hence the need for a well-designed intake structure whose main consideration will be the design of a diversion weir.

Objectives:

1. To identify the most suitable site for the diversion weir
2. To determine water demand including crop water requirements and domestic uses

3. To prepare detail design calculations and design drawings for the weir and the bill of quantities.

The intended purpose of an in-stream structure will help determine the type of hydrologic analysis necessary for design. Typically, the ability of a structure to perform its intended function and meet management objectives over an entire range of flows should be evaluated. If a structure is intended for diversion, structural component stability is paramount, and a high flow analysis will be most important in the stability assessment. However, it is also important to maintain upstream pools at or above the minimum level required for diversion at low flows.

If a structure is to be used primarily for fish habitat, stability may be less important with the low flow analysis taking precedence. This is to ensure useable habitat exists at low flows along with sufficient depth and velocity for fish passage. Low flow analyses may also be important to ensure habitat features (e.g., pools, notches, and chutes) are not filled or buried during the receding limb of a flow hydrograph. The effects of high flows should still be considered in the design to minimize damage occurring to habitat features during flood events. If fish passage is the primary objective, low flow and high flow analyses should be performed to ensure structural stability to maintain passable hydraulics at all flows. Design of any river spanning rock structure must consider its performance under both high and low flow conditions. While high flow designs focus on structural stability and upstream flooding impacts, low flow designs are constrained by fish passage criteria and maintenance of diversion capability.

Low Flow Analysis: Determining the low flows of greatest importance to a structure design again depends on the purpose of the structure and the indigenous fish species present in the subject stream. When used as diversions, the required upstream water surface elevation providing the necessary hydraulic head at all flows is a critical design component. For ramps with a continuous crest spanning the entire channel and common weir shapes (U-Weir, A-Weir, W-Weir), rating curves and head loss equations have been developed to ensure upstream water diversion over the range of design flows. Successful design for low flows requires careful consideration of physical and political constraints.

Meeting velocity fish passage criteria for high flows presents a challenge. For low flows, these velocities at small depths can be particularly complicated to incorporate into a rock weir design, as flows are concentrated toward the center of the channel. Conflicting guidance for fish passage by species, organization, and by State can further confound compliant design.

High Flow Analysis: Since most structures observed have failed after a large flow event has occurred, it seems rather intuitive that a high flow analysis is an imperative component of a structure's design. However, determining which high flows are of greatest importance could be subject to debate, depending on the structure's purpose (fish passage, irrigation diversion, pool habitat, etc.) and on the goals of the design (no tolerance for mobilization of structure versus dynamic constituent rocks). For most structures intended to be stable over the long-term, designs typically need to consider two critical pieces of information in the hydrologic analysis.

First, these structures must be designed using the discharge that is responsible for the maximum scour immediately downstream from the structure. Second, most structures are required, through regulatory means, to be designed such that the added feature does not impact the water surface elevations at a specific discharge

Spacing of Structures: Structure spacing is an important parameter to consider for structure design; however, meeting the high flow and low flow design criteria for structures in sequence may be challenging. The spacing of structures is highly dependent upon the goal of the project. Structures in sequence reduce the energy dissipation experienced by a single structure and create redundancy in the design. Multiple structures seem most appropriate when the objective of the project is irrigation diversion or fish passage. However, if the project objective is to create a large pool volume for holding habitat, structures closely spaced in sequence may limit the maximum pool volume attainable. Early field evidence suggests that structures were most stable when placed in series rather than individually.

Field observations suggest multiple hypotheses for why this is true. First, structures in series provide redundancy for meeting management objectives. For example, the probability of success for structures used to prevent channel incision may increase through the placement of multiple structures. If the downstream-most structure fails, upstream structures will continue to provide grade control. A second hypothesis for why several structures in sequence are more stable than independent structures is that the difference in water surface elevations on the upstream and downstream sides of one independent, large structure may create sufficient backwater pressure (potential energy) to instigate structure failure. To produce the same head, several structures in series distribute the energy dissipation and may increase the potential for structure success and longevity. Structure spacing design varies according to the purpose/intent of the structures and typically requires both low flow and high flow analysis as described in the previous sections. Structure spacing depends on channel slope, length ofbackwater effects created by downstream structures and associated depth, and length of the scour pool created downstream.

Low flow analysis takes into account the effects that multiple structures in series might have on diversion and fish passage criteria. Structures placed too far apart can result in failure to meet the required tail water depths for fish passage. Structures placed too close together can result in downstream structures being influenced by the hydraulics of the upstream structure, potentially limiting pool/scour development and structure failures due to flow impingement on the downstream structure crest. Additionally, at high flows, structures spaced too close together can result in an increase in the water surface elevation above allowed Federal Emergency Management Agency (FEMA) flood flow levels due to an overall increase in the channel roughness compared to the natural channel conditions.

Correlation between Peak Flow and Degree of Structure Failure: Structure failure is influenced by the magnitude of flows experienced since construction. A hydrologic analysis was conducted as part of a quantitative investigation (Reclamation, 2009b) to improve linkages between structure failures (as defined by constituent rock mobility) and flood discharges. The objectives of the hydrologic analysis were to provide:

• A description of streamflow data available at rock structure locations, • Flood frequency analyses at rock structure locations, and

• Estimated recurrence intervals and magnitudes of the largest flood since construction of each rock structure with topographic surveys. First, the nearest USGS stream gages were identified for the structures surveyed during field investigations.

Estimates of discharges with 2-, 5-, 10-, 25-, 50-, and 100-year recurrence intervals were calculated at each gage and adjusted by contributing drainage area to account for the distance between the gage and the structure location. From this information, an approximation of the recurrence interval and magnitude of the greatest discharge since construction was developed for each structure location. Determination of structure success or failure was complicated by the definition of success, whether it was sufficient fish passage, adequate head for irrigation diversion, habitat complexity, or other project goals.

For the purpose of Reclamation's field study, failures were categorized as either partial or full failures. Partial failures were those that may have undergone some minor shifting of the rocks from the original placement, but the structures were still meeting intended purposes to some extent. Full failures were characterized as those structures that required significant design modifications post-construction, those that have substantially departed from the original design, or those that wereno longer serving their functional role. Mobility of the constituent rocks occurs when one or more piece of the structure moves out of the original alignment. Structures may continue to at least partially perform their intended function despite experiencing some degree of motion.

Water Level Management: Most of the weirs in England and Wales have been constructed with the primary aim of water level management. The impoundment of water is clearly a central function of weirs as by their very nature they raise water levels relative to downstream conditions.Increased water levels may be required to provide sufficient draft for navigation, to permit the diversion or abstraction of water, or to provide a source of power. Many of the older weirs in England and Wales were constructed in connection with water mills and navigation improvements.

In cases where a river reach serves a navigation requirement, the increase in water levels is often accompanied by the need for controllability of level to ensure that canal banks are not overtopped, and that headroom under bridges is maintained.This is often achieved by the construction of a weir with a long crest, such that water level variation is small in response to changing flow conditions (the alternative is to have a gated weir that will allow regulation of water level).Side weirs are frequently used for water level management in navigable waterways

Weirs are also used to divert water into off-stream reservoirs or diversion channels, for flood defense purposes or as part of a water supply scheme.In providing raised water levels weirs may also be allowing the continued use of a reach of a river for recreation and amenity.Weirs are also used to maintain groundwater levels

Design Consideration of Pick up Weir

Elevation of Weir Crest: There are various factors that affect the elevation of the crest, but in our case, diversion of water is the purpose and the height should be sufficient to pond the water at a level that can facilitate design flow in the intake. The height of the weir is governed by the height of intake sill, depth of intake orifice and depth of the river at the intake site.

Length of Weir: The length of the weir depends upon the width of the waterway at the intake site. Crest length should be taken as the average wetted width during the flood. The upstream and downstream should be properly examined for the protection consideration. Rise in water level on the upstream of the structures after construction of the weir is called afflux. Fixation of afflux depends on the topographic and geomorphologic factors. A high afflux shortens the length of the weir but increases the cost of the river training and river protection works. For alluvial reaches it is generally restricted to 1m but for mountainous region it may be high. The water way must be sufficient to pass high floods with desired afflux. A weir with crest length smaller than the natural river width can severely interfere the natural regime of flow thus altering the hydraulic as well as the sediment carrying characteristics of the river.

Forces acting on Weir:

Water Pressure: It is the major external force acting on the weir. This is called hydrostatic pressure force and acts perpendicular on the surface of the weir and its magnitude is given by:

$P=0.5\times \gamma\times H^2\times b$

Where, γ = Unit weight of water, H = Depth of water, b = Width of

The Weir surface. This pressure force acts on H/3 from the base.

Uplift Pressure: Water seeping through the pores, cracks and fissures of the foundation material, seeping through the weir body itself and seepage from the bottom joint between the weir and its foundation exerts an uplift pressure on the base of the weir. The uplift pressure virtually reduces the downward weight of the weir hence acts against the dam stability. The analysis of seepage is done using Khosla's Theory. Khosla's Theory is the mathematical solution of the Laplacian equation and it is easy and accurate method for seepage analysis.

Silt Pressure: The silt gets deposited on the upstream of the weir and exerts the horizontal and vertical pressure as exerted by the water. So, flushing of the silt should be done regularly to reduce its effect of destabilizing the weir. It is done by the use of undersluice gate. The silt pressure is given by the relation:

$P_{silt} = 0.5 \times \gamma_{sub} \times H^2 \times K_a$

Where, γ_{sub}=Submerged unit weight of silt; H= Depth of silt deposited and K_a= Coefficient of Active earth pressure

The silt pressure force also acts at a height of H/3 from the base.

Weight of Weir: The weight of weir and its foundation is the major stabilizing/ resisting force. While calculating the weight, the cross section is split into rectangle and triangle. The weight of each along with their center of gravity is determined. The resultant of all these forces will represent the total weight of weir acting at the C.G. of weir. Simply, when the sectional area of each part is multiplied by unit weight of concrete, weight of that part is obtained. The weir is designed with ogee profile for spilling over its length. Hence weight is calculated by knowing its section and multiplying by its unit weight.

Modes of Failure & Criteria for Structural Stability of Weir:

Overturning about the toe: If resultant of all the forces acting in the weir passes outside, the weir shall rotate and overturn about the toe. Practically, this condition will not arise because the weir will fail much earlier by compression. The ratio of resisting moment to the overturning moment about the toe is the factor of safety against overturning and it should greater than1.5 for safety.

Compression or Crushing: While designing the weir section it should be so design that the resultant should pass through middle 3 rd part of the section to avoid the possible tension on the weir section. The section should be totally in compression. So, weir should be checked against the failure by crushing of its material. If the actual compressive stress may exceed the allowable stress, the structure material may get crushed.

Sliding: Sliding will occur when the net horizontal force above any plane in the weir or at the base of the weir exceed the frictional resistance developed at that level. For safety against sliding, SSF should be greater than 3.5. To increase the value of SSF, attempts are always made to increase the magnitude of q, which is achieved by providing the stepped foundation, ensuring the better bond between the dam base and rock foundation etc.

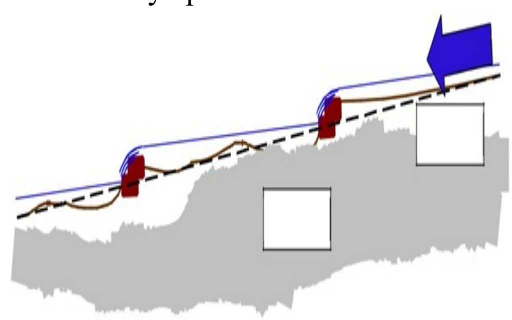
Design and Analysis: Excavation for Foundation in ordinary rock (including HDR) without blasting including boulders above 0.30m up to 0.60m diameter for dam, spillway, intake structure and other apparent works and placing the excavated material neatly in dump area or disposing off the same as directed etc. complete with initial lead up to 1km and all lift.

S.No	Description	Details
1	Catchment area	24.000SQ.kms
2	MFD(considered for design)	180.50cumecs
3	T.B.L	+433.665m
4	M.W.L	+432.665m
5	FTL/ crest level	+430.150m
6	OMFL/T.W.L	+430.150m
7	Length of pick up weir	21.0m
8	Type of weir	High efficient

Providing homogeneous embankment using soil from approved borrow area in layers of 25 to 30cm before compaction including cost of all materials, machinerylabour, all operations such as excavation ,sorting out, transportation, spreading of ,soil in layers of specified thickness ,breaking clods ,sectioning, watering, compacting to density control of not less than 95% or stipulated using sheep/pad foot roller etc complete with initial lead up to 1km and all lift.

Providing and laying insitu vibrated M-15(28 days cube compressive strength nopt less than 15N/sq mm) grade cement concrete using 40mm down size approved,clean,hard grade aggregates with placing and plums of size 150mm to 80mm upto 15 percent for gravity type structures including cost of all materials, machinery, labour, formwork. complete with initial lead upto 50m and all lifts.

Providing and laying insitu vibrated M-20(28 days cube compressive strength not less than 20N/sq mm)grade cement concrete using 20mm down size approved, clean, hard graded aggregates for wearing coat including cost of all materials machinery, labour, formwork, cleaning, batching, mixing, placing in position in alternate panels, leveling, compacting vibrating, finishing, curing, packing joints with asphalt mortar etc.,complete with initial leadupto 50m and all lifts for body apron.



Typical longitudinal profile of sediment deposition and pool patterns

RESULTS & DISCUSSION: A survey that was carried out helped in knowing the diversion weir dimensions. At the point where the weir is to be constructed, the river is 22m wide and 1.5m deep hence the weir to be constructed is 21m long and 433.3m high.

The scheme demand was calculated by calculating the gross irrigation requirement and then multiplying the value obtained, in this case 180.50cumecs with the total area of the scheme that will be put under irrigation, which is 240sq.kms and MFD=180.50cumes, T.B.L=433.665m M.W.L=432.665m, F.T.L/crest level=430.15m, assuming all the 1200 farmers had a family of about six people and the sum of both was approximately 170l/s. This value is much more greater than the authorized amount by WRMA which is 28.125l/s.

I therefore used the authorized discharge of 180.50cumes to design my pick up weir. This discharged helped in selection of pipe sizes to be used as off take pipes. To satisfy this demand, I used two 400 mm pipes at intake chamber for off take and a 150 mm pipe for scour. All the pipes were galvanized steel. To ensure that all the farmers got water equally, the calculated amount was divided into six parts and each part was allocated about 8 hours of irrigation after each and every day.

The designed weir was checked for stability by calculating the moments about the toe and it was found to be stable against water pressure, silt pressure, uplift and overturning. It was however not safe for against sliding and therefore a key with dimensions of 0.08m by 0.091 meter was to be included in the design.

Conclusion: The objectives of the project were met since I was able to identify a site suitable for the weir construction, dimension the weir whose calculations revealed it was stable, calculate and come up with the scheme demand hence make recommendations on how farmers are to share the water and calculate and come up with a bill of quantities.

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