Self-Sustaining Geomembrane Lined Irrigation Dam

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Abstract

This paper is an overview of a modern and simple way to construct a self-sufficient irrigation dam. It addresses the challenges that go together with operating a self-sufficient irrigation dam in a remote area, where space, reliability of power as well as skilled manpower are major considerations.

Keywords: *Self-sustaining irrigation dam, solar power, HDPE Lining*

1. Introduction

Jack Brotherton, a successful entrepreneur and farmer, planned to build a self-sufficient irrigation dam. He had planted macadamia trees on a small piece of land near Hazyview, situated in the central region of Mpumalanga province, which has the perfect climate for macadamia farming. He however intended to plant more trees, which made the need for an irrigation dam urgent. The need, however, came with certain concomitant challenges:

- He was planting macadamia trees on a relatively small piece of land where farmland is costly.
- Considering the above, it was imperative to optimize space.
- Clearly, a water source for irrigation was required.
- It was also vital to find an alternative to drawing electricity from the national grid, which is unreliable.

Brotherton brought out his entrepreneurial tool kit and began thinking outside the box. After a short while, he came up with innovative ideas that, with the help of top professionals and materials, would give him what he needed – a self-sufficient irrigation dam.

2. The Project

It was agreed that the dam would include a geosynthetic liner to prevent seepage; and feature solar panels to meet the demand for a stable power supply. The panels would be installed above the dam's water level to save space and to reduce evaporation.

As the water in the dam is used for irrigation in the agricultural sector, certain practical issues needed to be considered, such as ensuring: a constant supply of water; the secure storage of the water; a consistent power supply; optimization of land; the reduction of the risk of theft; and the availability of constant supervision.

2.1 Location

Hazyview, situated in the central region of Mpumalnga province, has a perfect climate for macadamia farming. Together with the prime land however comes with limited space. Farmers requires space for planting crops as well as a dam for water usage.

2.2 The Water Source

As we know, South Africa is a water-scarce country. Once permission is granted for an individual or a farm to collect water from a source, it must be properly harvested, stored and used optimally, to prevent wastage, as stipulated in the agreement with the Department of Water and Sanitation.

In this case, the water is collected from the nearby Sabie River Canal System. This man-made canal branches off to the north from the Sabie River, distributing water to nearby farmers for irrigation purposes. The quota for this application is confidential and the agreement is that this irrigation dam will be used as a balancing dam and all excess water will be placed back in the lower end of the Sabie River canal system.

For this application, the water requirement for the crop is $30m^3$ of water per hour for six hours per day. This system aims to irrigate 60Ha of macadamia trees, which are currently four years old as the two-year-old seedlings were planted in 2016.

This particular water storage facility, or dam, has a capacity of $14\,500m^3$ which can irrigate the trees in a ***drought for a minimum period of two and a half months***.

2.3 Securing a Reliable Electricity Supply

In electrifying this facility, Brotherton made provision for electric fencing, pumping the water, lighting at night and the power management system, among other requirements.

Brotherton judged the national grid suitable for backup should the solar supply not meet the necessary demand. This is, however, unlikely as the 220 panels that have been installed are delivering 170Kw hrs per day, 11% more than the requirement. (Provision has been made for 320 panels, allowing additional panels to be installed.)

Each panel is a 305-watt Poly Crystalline unit, manufactured by Jinko.

For this phase, two systems were installed. Each system has two-variable speed drives and are rated at 30Kw each.

2.4 Housing the Panels

Besides needing to save space on the farm, Brotherton had other serious and potentially costly concerns. The panels are expensive, reliable and hard to come by, making them a popular target for thieves.

The need for on-demand power therefore boiled down to security and space. A suitable solution required proper planning and with careful consideration and creative thinking. Brotherton, together with Telenetix Solar, developed a structure for housing the solar panels. The design allowed for the structure to be installed above water level inside the dam to eliminate or at least reduce the risk of theft. As a bonus, evaporation would also be marginally reduced.

When all the 320 panels are installed, 20% of the water surface area will be covered in shade when the dam is at 100% capacity.

To accommodate the panels the structure needed to be anchored in the ground. This would provide the sturdiness and stability needed. The design required 72 wooden columns at approximately 250mm diameter, which were placed on average 4m apart.

The challenge however was, that the columns would penetrate the HDPE lining, which would then no longer prevent the water seeping into the ground. So, the wooden columns were installed before the HDPE lining. To add to the complexity of the task, the diameters of the columns were not all the same.

Special HDPE pipe boots were manufactured to fit around PVC pipe sleeves, which were fitted over the columns prior to the Solar panel support frame being installed. A non-shrink grout filled the space between the column and the pipe boot to provide the water tightness. Refer photograph 1.

Photograph 1. Penetrating Column connection to the future HDPE lining.

2.5 The Liner

There was no special requirement from the Department of Water and Sanitation relating to the geomembrane being installed in an irrigation dam in the area.

However, all the energy, innovation and resources put into this project would be fruitless if the water that is intended for irrigation is at risk of seeping into the earth. Based on experience, Brotherton, one of Aquatan's valued clients, decided to install a geomembrane that is guaranteed by Aquatan to last for 15 years. His confidence ~~trust~~ in Aquatan's products and integrity led him to choose a 1.5mm HDPE liner.

The difficulty, however, was synchronizing the earthworks with the liner installation as the liner required a surface that was fit for a 1.5mm HDPE geomembrane. With all the different activities in and around the facility, the surface was disrupted continuously. Furthermore, and as mentioned before, the boots around the pre-installed columns had to be manufactured, delivered, and installed on site after the erection of the columns and prior to the installation of the aluminum structure for the support of the panels. Planning was crucial, and the deadline was *tight*. The liner was installed immediately after the frame and the panels were installed and functioning.

A further challenge was to install the 7.0m wide sheets to accommodate the 4m spacing of the solar panel supporting columns.

3. The End Product

The end product fully satisfied Brotherton's specifications. He forecast and obtained a 60Ha macadamia crop, situated in a prime location, with a reliable water supply. He also had an appropriate storage facility for the water, featuring an automated irrigation system with a source from a balancing, HDPE lined dam with a secure and independent power supply.

References

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