Construction of the first Crystal Lagoons Project in South Africa

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Abstract

This paper reports on the liner installation of the First Crystal Lagoon in South Africa that was installed by Aquatan. The lagoon was lined with a proprietary white/black geomembrane. The installation had unique technical and aesthetic challenges associated with it. A total of one thousand two hundred and forty seven (1 247) metres of extrusion welding had to be done with four hundred and forty two (342) metres that had to be done horizontally in a perfectly straight line to a vertical wall that had continuous curves of varying radiuses.

The black edge of the wedge seams had to be concealed to avoid interference with the aesthetics of the project. Unique and innovative tools and equipment had to be developed to execute the installation to a quality standard that exceeded the client's requirements.

Keywords: *Crystal Lagoons, Innovative Welding Equipment, Quality Geosynthetic Installations*

1 Introduction

In 1997 Fernando Fischmann planned his second real estate development in San Alfonso del Mar in Algarrobo, Chile. The development had a beautiful ocean view, but the ocean was unfavourable for visitors due to the cold water, high waves and under water currents.

Fernando was an ambitious entrepreneur and he dreamt about an environment where the occupants of his development could enjoy a beach-style living that is clean and safe. He started to plan this lagoon concept and he approached a company to assist with technology to assist with the cleaning and operation of the water system to ensure the water quality is pure at low costs.

The lagoon which has a volume of two hundred and fifty thousand cubic metres (250 000m^3), equivalent to six thousand (6 000) standards swimming pools, was constructed and completed, but the water did not have the turquois colour that he envisioned and after a while the water started to turn green and the company that he approached could not provide any

solution. Many of the approached companies said that the technology that Fernando seeks does not exist and that it cannot be developed.

After numerous turndowns Fernando being a Biochemist started to do his own research. It took seven years of experiments and analysis to finally achieve his dream.

The initial development of San Alfonso del Mar was for four hundred (400) residential units, but after introducing the Crystal Lagoon's technology the development was expanded to one thousand four hundred (1 400) residential units. The lagoon occupied an area of eight hectares (8ha), equivalent to eight rugby fields, with a stretch of just over a kilometre. This lagoon was awarded the 2007 Guinness World Record for the largest crystalline man-made lagoon in the world.

Crystal Lagoons was founded by Fernando Fischmann in 2007 and the concept is patented in 190 countries across the world.

Crystal Lagoons have developed and patented a state-of-the-art environmentally sustainable technology which allows crystal clear lagoons of unlimited size to be built and maintained at very low operating costs.

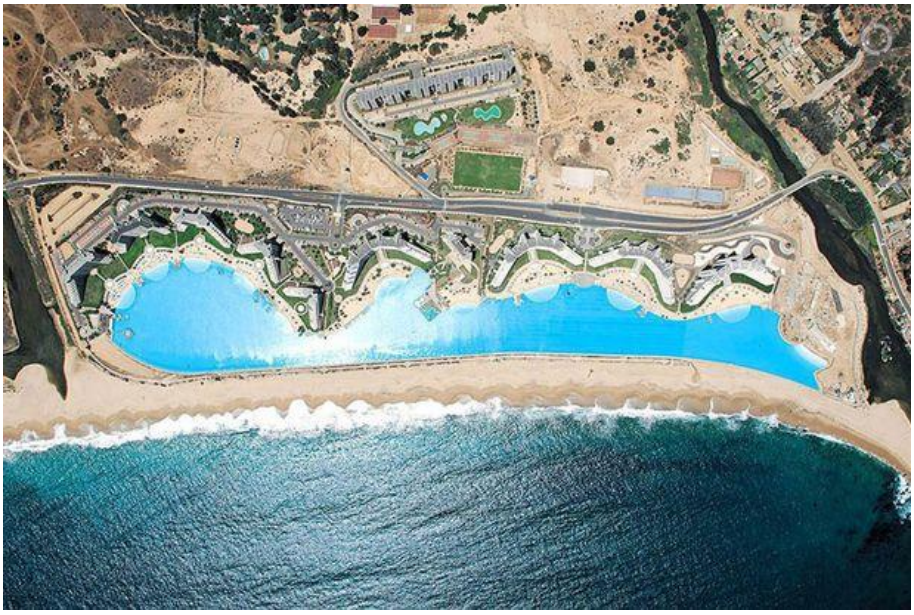

Figure 1: Google Earth view of San Alfonso del Mar

2 Project Introduction

A well-known local developer has partnered with Crystal Lagoons to construct South Africa's first Crystal Lagoon. The development, also known as The Blyde, is situated on the outskirts of Pretoria East.

The development entails the construction of various apartments with a one and a halve hectare (1.5ha) lagoon that is equivalent to just over two (2) rugby fields. The shape of the lagoon is illustrated in Figure 2 below.

Aquatan was nominated by the client to carry out the installation work of the Geotextile and proprietary LLDPE geomembrane. They further assisted the contractor with guidance on how to cast the Polylock profile into the concrete works.

Figure 2: Plan view of the lagoon prior to lining commencement

3 Project Overview

The liner that is used on these lagoons is a proprietary White/Black 1.35mm Linear Low-Density Polyethylene (LLDPE) based smooth geomembrane that is exclusively manufactured for Crystal Lagoons. The proprietary LLDPE geomembrane's excellent flexibility and consequent drape-ability properties make it very appropriate for the Crystal Lagoon application.

Apart from the three beach entry points into the lagoon a vertical concrete wall was constructed along the perimeter of the lagoon. Two lengths of Polylock HDPE cast-in profile, was built into the foundation and top of vertical wall perimeter concrete wall, refer Figure 3. The Polylock in the foundation of the vertical wall have two extrusion welds, nine hundred and five meter (905m) in length, and the top of wall Polylock only one extrusion weld, three hundred and forty two meter (342m) in length.

The lagoon liner system consisted of the following geosynthetic layers from the bottom upwards:

- Non-woven needle punched geotextile protection layer installed on top of the prepared earthworks.
- Geocomposite drainage strips installed on top of the herringbone drains.
- 1.35mm White/Black proprietary Crystal Lagoon LLDPE Liner.

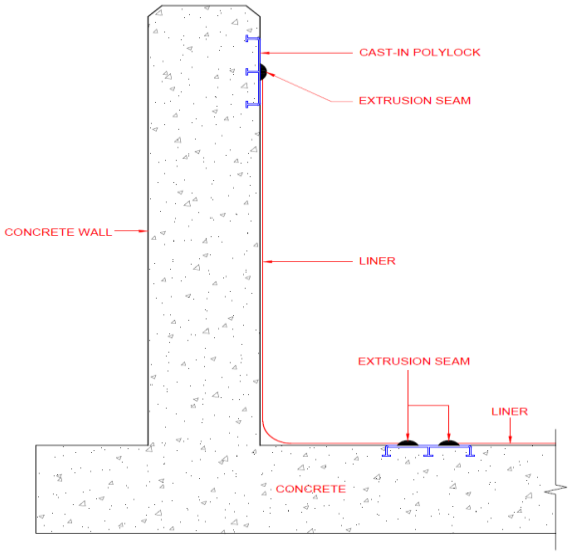

Figure 3: Cast-in Polylock and associated extrusion welds

4 Technical Challenges

This project had a number of unique technical challenges from a geosynthetic installation point of view. The project is a milestone project for all stakeholders involved and everyone was committed to execute the installation to the highest quality and aesthetic standards.

The following unique technical challenges were experienced on site from a lining installation point of view:

- **Wedge Welding:** The Crystal Lagoon Liner is a white/black geomembrane. The geomembrane is installed with the white side facing upwards. The welding is done by a wedge weld seam with an approximate material overlap of 150mm. The installation specification required that the edge of the exposed overlapping geomembrane be invisible.

- **Extrusion Weld:** The main challenge that the linings installer was faced with was the achievement of a consistent horizontal extrusion weld at the top of the vertical and varying radiused perimeter wall. The most visible extrusion weld needed to be carried out at a constant particular shape, with precision, maintaining the quality thereof and at a perfectly straight line. The average height of the top of wall extrusion weld is six hundred millimetres (600mm) above the floor level. The installer came up with a number of ideas that assisted with the extrusion welding process after some unsuccessful efforts. The uncomfortable seaming height resulted in an uncomfortable body positioning for the welding operator, not to mention the weight of the extrusion welding machine and the constant pressure and speed required to produce a successful seam was a real challenge.

5 Technical Outcomes

Innovative thinking was applied, and solutions were developed to overcome the above technical challenges. The solutions developed were as follows:

- **Wedge Weld:** Using IAGI Certified Welding Technicians, the Wedge Welding machine was modified and applied to fully and consistently meet the project specification.

- **Extrusion Weld:** Using the unique Aquatan rotating tip extrusion welding machine with an adjustable profiled seam, combined with a specifically constructed mechanical tool and using IAGI Certified Welding Technicians (CWT), fully homogenous and consistent extrusion welding was achieved against the vertical wall**.** The welding mechanism was specifically designed on a computer aided design software package which greatly reduced the time from design to manufacture. A number of obstacles had to be overcome during the design and manufacturing stage but ultimately the machine was perfect for the job.

Figure 4: Mechanically-driven extrusion welding mechanism busy with the horizontal extrusion weld.

Figure 5: Close-up of the horizontal extrusion weld.

6 Quality Assurance

The liner installation was carried out according to SANS 10409 and the project specific specifications to the utmost satisfaction of the client.

The liner installer applied its fully automated and proprietary digital AQ Cloud Quality control system backed up by a full Electric Leak Location (Arc Test) survey to ensure the integrity of the final barrier.

The Electric Leak Location survey was conducted after the final sign-off of the liner installation. Due to heavy rains that were experienced after the sign-off, the lagoon was full of muddy water. As a result of this, the lagoon was emptied and all mud was removed. A final Electric Leak Location survey was conducted to ensure that the integrity was not affected during the cleaning operation.

7 Conclusion

By making use of the proprietary AQ Cloud Quality control system the linings contractor can be assured that the correct steps are followed during data capturing as the system prevents you from continuing until all the relevant data has been captured.

Everyone involved knew that the lining project would be a challenging task but with team work, perseverance and an innovative mind-set the project was completed successfully on time and to total satisfaction of the client.

Figure 6: Final product with lagoon in process of being filled

7 References

https://www.crystal-lagoons.com

https://www.crystal-lagoons.com/latest-news/crystal-lagoons-signs-first-project-in-south-africa-bringing-beach-life-to-gauteng/