UNIVERSIDAD POLITÉCNICA DE MADRID

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Construction of harbour facilities for ships near the permanent base (24)

British Antarctic Territory Base Project (Pendragon Blue)

English for Professional and Academic Communication – ETSII

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Table of Contents

Abstract

Spanish engineering firm Ruido and Alcalinidad S.L., as already stated, won the tender that gives them full rights to build a polar base on the British Antarctic. We as an external company, construction subcontractors, have been assigned with the construction of harbour facilities. Obviously, we have not had the opportunity to build something similar to this. We have been involved in many other construction projects, but never have a chance to exploit the polar market. We accepted the project as a challenge and we believe that it will get us out of our comfort zone. Building the pier of the main project is one of the first step to take, we accept that importance and we want to innovate and reduce costs. Later on the report, we are going to explain why we opted for an ice pier. The purpose of the polar base is to realize new scientific studies, and we assume that it is not cheap, and they do not make any profit. That is why we want our client to spend the least possible.

Introduction

In order to follow the requirements with the client, we want to create the most optimized harbour facilities possible. We would like to be bold but always within limits because the main purpose of the facilities is to be able to work as an area where ships could unload and dock without suffering any problems. On this report we are going to review the process behind each decision. As it will be mention on the first section, to achieve it we will have to study the conditions that the British Antarctica offers and study similar and previous examples. Once we understand the real options, summarized on the second section, that could be develop without taking too much risk, after, like any other project we will try to optimize it and reduce costs. The final dimension of the project is described on the last two sections.

Location

Initially, the British Government launched a competitive tender for the construction of a Polar base in the British Antarctic Territory and the adjacent Adelaide Island. When defining the tender, the government did not specify an exact location. So, we are free to select any option, provided that we do not exceed the geographical limits of the British territory.

First, we need to clarify what does the British Antarctic Territory encompass. In terms of its coordinates, the latitude it is delimited from the South pole to 60ºS and the longitude between 20ºW and 80ºW [1]. Figure 1 helps to understand the coordinates indicated.

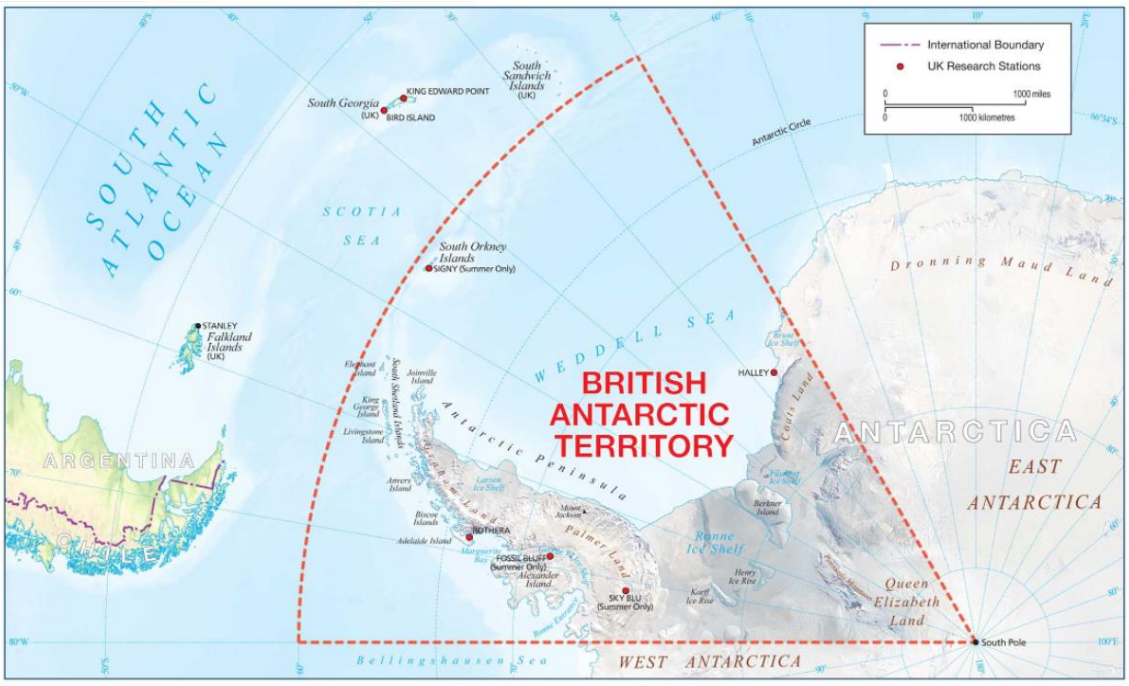

FIGURE 1 - MAP OF THE BRITISH ANTARCTIC TERRITORY

Having demarcated the possible location, now we must define the requirements that the harbour facilities will need. If we study carefully these requirements, later it will reduce cost or avoid problems. That is why we define them before choosing any final spot.

Let us start with the essentials, that all kind of ports need to take into consideration, then we are going to specify the importance of the conditions that we will face on our case. To build the best facilities possible, we want the space to fulfill at least a minimum shelter and draft or depth. The first property mentioned, the shelter, is very important in terms of the operations and maneuvers that ships will face when trying to get into the facilities. This is even more important in the oceans around the Antarctica because wind and ice blocks can cause problems in ships. Concerning the security of those actions, we will need to keep a certain draft or depth. Also, this will ensure the dock of ships without grounding [2]. While these are features that any port of the world share, we must adapt ours to the conditions and environment. We could sum them up by adapting our facilities to the temperature. We have to take more precautions than usual because our facilities would be isolated from civilization. In terms of construction, we have to keep away from not only extreme weather, that is impossible there, but also the ice foundation. If we assemble our facilities on an iceberg or near the ocean the probability of collapsing or downfalling will increase. We need to adapt to the surroundings and conditions without increasing the costs, that's why we are searching for a location with natural shelter.

Bearing in mind that the firm and British Government have not select any location for the final Polar base, we will choose a place near other bases and Adelaide Island that fulfill the conditions mentioned. Also, as you may see on figure 2 and 3, the zone preselected is connected to south America by the shortest sea

stretch. This stretch is called Drake Passage, in our case it is between the future location and Chile [3].

FIGURE 2 - AREA OF THE POSSIBLE SITUATION

FIGURE 3 - TEMPORARY LOCATION OF THE FACILITIES

The last figures are hypothesis, we need to adapt to the base location and study the conditions mentioned on that area.

Similar Facilities

To begin with the plan, we studied similar projects and polar bases that had already been carried out, in that way we could have a good grounding to start

ours or new ideas to apply. As a summary we are going to present McMurdo Station and a recent project that is being developed by the Chilean government.

Before describing the examples mentioned above, we are going to show the information collected about the polar bases and their necessities. Most of them are designed to be the home for around 60 people, being McMurdo's the biggest for 1200 [4]. As it is known, these platforms are temporary. The time that they are active is not define, the duration relies on the scientific studies being executed. We will reserve the temporary condition for later, it will take an important role in upcoming decisions. Another recurring feature of the Antarctic emplacements is the arrival of a couple ships with food, materials, fuel, etc. This happens once a year, typically in summer for its conditions.

Now, we are going to focus on explaining the difference between McMurdo's pier and the design of the Chilean. The idea behind both is the opposite also, one is from the seventies and the other is awaiting bids [5] [6]. McMurdo's pier, which is the world's southernmost, is based on an ice structure. There, we can ensure that the conditions are similar. This idea takes advantage of the conditions around the Antarctic, making it possible to be recyclable. As a consequence of the temporariness stated before, this pier will disappear with the ending of the scientific studies. This could be a big advantage to add to our project. On the other hand, the Chilean point of view is more classic, trying to build a port as if it were any other Chilean coastline. The pier will be built with concrete structures, having studied the composition of the concrete for making them freeze-resistant. The main problem, apart from the costs, is that building a port needs heavy machinery, a lot of materials, etc. And these is not possible without a high number of ships and employees. And besides the labor's cost, it was estimated a first inversion of 465,822,578 dollars [7]. By transferring this to our facilities we could reduce costs, because the Chilean expected a polar base for 131 people, and we expect less [7]. Anyway, this will be out of our budget. Returning to McMurdo's station, which was made for 1200 people, I believe that it was an innovative way of adapting the project to its circumstances, and the project started in the seventies [5]. Although I could not find any number of its cost, I assume that it was lower and easier because it does not need heavy machinery other than a big pump. Moreover, materials and manpower are reduced with the idea.

As far as I am concerned, we can take advantage of the idea of creating and ice pier. The main advantages of this decision are: reduction of costs and transportation, temporary construction, easier to build from scratch, reduction of manpower. I believe that the advantages could be summed up with the word adaptability. Why adaptability? Normally scientific research on the Antarctic is repeated on the same spot, with this type of construction if a block of ice collapses or the investigation needs to relocate the pier itself could adapt to circumstances or locations.

Ice Pier

Eventually, on this section, after the conclusion previously developed, we are going to describe as specific as possible the implementation of an ice pier. We are going to gather the higher amount of information as possible, so it could be easier to estimate purchases, timeline, employees, etc.

First of all, we need to clarify how an ice pier is executed. We have summarized the process and later we would go into details. As already mentioned, the basic idea behind all the construction is the utilization of frozen water in winter as the foundation of our wharf [8]. It starts with the construction of a snow berm along the perimeter of the soon-to-be ice pier. Obviously, this and other ice parts that are going to be mentioned over the course of the description need a minimum depth, that will depend on future studies and the quantity to be download on its surface. Next, the first ice blocks are inserted inside that perimeter followed by pumped water so they can flood. Then, it is time for the water at the top side to freeze. The same operation is repeated until the desired depth is reached. Inside the ice packs it is recommended to embed steel pipes, like reinforced concrete. The steel pipes could be connected by a reinforcement mat of steel cable. That will be the ended of the foundation, now we need no adapt it. We would add some wooden poles, which are necessary for: electrical support, function as bollards to secure the pier to the shore, etc. Finally, it is essential to add a layer of volcanic gravel tops off the pier. It will provide a non-slip surface and would insulate the ice surface from the sun.

FIGURE 4 - EXAMPLE OF THE MCMURDO'S ICE PIER

Having presented the steps to follow, we need to adapt them to our necessities. As a fairly accurate notion, we can compare the size of McMurdo's pier and their requisites. Its pier has 9-20 feet (274 – 609 cm) thickness and a surface like other contemporary piers, being approximately 800 feet (24000 cm) long by 300 feet (9100 cm) wide [8]. Again, in McMurdo's station inhabit 1200 people, at least 130 all the winter, while ours is expected to have around 60 people. To be able to supply stock for a year of basic needs they need one ship, another one brings about 6 million gallons of fuel [9]. We forgot to mention that the pier is equipped with heavy equipment, like a crane, and a bridge so trucks move the containers to land, as we can see on figure 4. To complete the data presentation a seagoing vessel is 350 meters long and can transport near 9000 containers. With all this

collection of information we can start presenting the possible dimensions of our wharf. We would need to download a ship once a year, bringing less weight, so we decided to build it 300 meters long by 60 meters wide and 3 meters thick. At the top we will include 20 cm of volcanic gravel. To this we will add a crane and a 10-meter-long bridge capable of supporting at least one truck at a time.

Timeline

Having already decided the type and size of our project, we are going to organize a calendar that could be replicated each year. Considering what we mentioned before that only once a year a ship will dock, besides other boats loaded with a few people. In addition, the conditions around the Antarctic will make it very difficult for ships to navigate in winter. That is why there is not going to be any stressful planification and deadlines will be very flexible. However, we purpose a very general schedule to have an overview of the design.

1) Study of the terrain and the properties of the sea.
2) Enclosing the selected area of annual ice with the placement of the collapsing tube
3) Flooding the enclosed area with a quarter or half a meter of seawater, also the tubing
4) Few days to wait for water to completely freeze
5) Repeat process until we reach the 3 meters thickness, adding more tubing to improve stiffness
6) Study the results of the flooding.
7) Improve the results by pumping in a different way or zones
8) Addition of the extra elements such as wooden poles, steel cables. Fixing its location to land
9) Distribution of the volcanic gravel until it results on a uniform 15-20 cm layer.
10) If the pier is separated from land, it will be necessary to assemble a bridge with a metal structure. This process will last not more than one or two days.
11) Review period. Addition of load to the surface and observe if the main structure cracks or collapse.
12) After last results, complete the wharf by putting machinery and a crane.

Cost Estimate

To complete the characterization of our project we are going to recap the material, employees and machinery required to carry it out, trying to anticipate undersupply. It is necessary to calculate or estimate the inversion because at the end if we have to spend a huge amount of money, we will have time to change of idea.

To make it easier for comprehension the data will be shown by a list:

- Water Pump
  - Quantity: 1
  - Price: around 10,000 $
- Steel cable (25 mm diameter)
  - Quantity: 5000 meters
  - Price: 50 $/m = 250,000 $
- Steel pipe (50 mm diameter)
  - Quantity: 2100 meters
  - Price: 35 $/m = 73,500 $
- Wooden Poles
  - Quantity: 200
  - Price: 5 $/u = 1,000 $
- Volcanic Gravel
  - Quantity: 3.5 tons
  - Price: 0.50 $/kg = 1,750,000 $
- Employees
  - Quantity: Around 100
  - Price: A normal worker has a salary around 20 $/h, but under these conditions it gets more expensive, up to 40 $/h.
- Crane
  - Quantity: 1
  - Price: More than 10,000 $
- Transportation
  - Ship's consumption: 2000 l/h
  - Fuel's price: Now around 1.1 $/l

If the employees work for an entire month, working 8 hours a day. With certain assumptions, we would obtain a first estimation close to 3,116,500 $.

Conclusions

As a conclusion, we are going to make a review of the main idea behind the report. The target of the leading project was to build a polar base from scratch, but our work was reduced on the harbour facilities that the base will require. We accepted the order and tried to think about the most innovative way to reduce costs and solve the problems that could appear because of Antarctic's conditions. According to the options studied on the report, we decided to work on an ice pier. The causes that influenced on our decisions were very clear, before we summed them up with the word adaptability. We ended by choosing the option that is more flexible for adapting to the surroundings, without an increase of the inversion on the project and minimizing the risk to the marine environment. Thanks to the ice structure it is recyclable and will not leave an important mark on the Antarctic's landscape.

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