

Creation of the Palm Island

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Abstract: - The Palm Islands are an artificial archipelago in Dubai, United Arab Emirates on which major commercial and residential infrastructures are constructed. They are being constructed by Nakheel Properties, a property developer in the United Arab Emirates, who hired Belgian and Dutch dredging and marine contractor Jan De Nul and Van Oord, some of the world's specialists in land reclamation. Each settlement is in the shape of a palm tree, topped with a crescent, and will have a large number of residential, leisure and entertainment centres. The Palm Islands are located off the coast of The United Arab Emirates in the Persian Gulf and will add 520 kilometres of beaches to the city of Dubai. These islands are a new step to mankind to develop land on water and find more resources for the increasing population.

1. INTRODUCTION

The Palm Islands are an artificial archipelago in Dubai, United Arab Emirates on which major commercial and residential infrastructures are constructed. They are being constructed by Nakheel Properties, a property developer in the United Arab Emirates, who hired Belgian and Dutch dredging and marine contractor Jan De Nul and Van Oord, some of the world's specialists in land reclamation. The islands are:

- (1) The Palm Jumeirah,
- (2) The Palm Jebel Ali and
- (3) The Palm Deira.

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The Palm Jumeirah and The Palm Jebel Ali comprise approximately 100 million cubic meters of rock and sand. Palm Deira will be composed of approximately 1 billion cubic meters of rock and sand. All materials are being quarried in the UAE. Among the three islands there will be over 100 luxury hotels, exclusive residential beach side villas and apartments, marinas, water theme parks, restaurants, shopping malls, sports facilities and health spas.

The creation of the Palm Jumeirah began in June 2001. Shortly after, the Palm Jebel Ali was announced and reclamation work began. The Palm Deira, which is planned to have a surface area of 46.35 square kilometres, was announced for development in October 2004.

2. LAND RECLAMATION

Land reclamation, usually known as reclamation, is the process to create new land from sea or riverbeds. The land reclaimed is known as reclamation ground or landfill. The creation of new land is for the need of human activities, also Agriculture was a drive for land reclamation before industrialization. In South China, farmers reclaimed paddy fields by enclosing an area with a stone wall on the sea shore near river mouth or river delta. The species of rice that grow on these grounds are more salt tolerant. Another use of such enclosed land is creation of fish ponds. It is commonly seen on the Pearl River Delta and Hong Kong. Such reclamation also attracts species of migrating birds.

The breakwater crescent of Palm Jumeirah is about 11 km long and 200 m wide in cross section. It stands over 13 feet above low tide sea level and sits in 34 feet of water at the deepest point. The crest of the breakwater is 3-4m above mean sea level. The seaward slope is one in two. The composition of the breakwater consists of coarse sand, quarry run, and 5-6 tonnes of sand. The seaside breakwater is protected by rubble mound armour. The lowest layer of the breakwater is filled with sand. Rocks weighing one ton were placed on top of the sand followed by two more layers of rocks. In addition, there are two 328-foot openings on each side of the breakwater to enhance water circulation. Water renewal time is approximately 13 days. Water circulation around the fronds and open sea is critical for marine life, supply of oxygen and the removal of pollution. Furthermore, there is a retaining wall between the Crescent and fronds. Another layer of rock is placed in front of the wall to reduce overtopping quantity.

To start the reclamation and to construct breakwater the first step was to consult with the experts of land reclamation. Belgian and Dutch dredging and marine contractor Jan De Nul and Van Oord were hired for the purpose. The biggest problem that needed to be resolved was how an island made out of sand would remain in position. Solutions to that problem were very complex because it is dependent on many factors such as the strength of Dubai's storms, the height of waves and tidal surges, and global warming's impact in raising sea levels. One of the biggest concerned was how waves could accumulate over long distances via persistent winds and large currents potentially causing severe destruction to the islands. Studies shows that the Arabian Gulf is the perfect place for such construction because with a depth of 30 m and a width of 160 m, it is too short and shallow for the creation of immensely destructive waves. Nonetheless, even though typical Gulf climate is mild, during the Shamal season, weather conditions are different. During the Shamal season, from November to April, many storms develop over the Northwestern part of the Gulf, where the winds are the strongest, travelling at velocities up to 56 km/hr, and drift toward the Southeast within a few days. Waves ranging from 1 to 2 m high can form from these strong winds, and not to mention, the potential for a catastrophic storm that hits once in a hundred years. As a result, scientists designed the crescent breakwater structure to surround the fronds of the Palm Islands in order to protect the islands for high waves and storms. Scientists calculated that for breakwater

crescent to be functional along the 5 km radius of Palm Jumeirah, it had to be at least 3 m above waves, 11.5 km long and 200 m wide in cross section. The company that constructed the breakwater crescent was Archirodon Overseas. This project required 9 barges, 15 tugboats, 7 dredgers, 30 heavy land-based machines, and 10 floating cranes. The islands themselves would be made out of an obscene amount of sand, dredged from three massive barren sea beds nearby (from the Gulf), while the breakwater crescent out of rock and sand, and though mostly rock. The bottom sand layer of the crescent breakwater is 7.4 m thick. The challenge of dumping this sand layer was that it had to be done when the sea was the calmest to ensure stability. Then, barge-loads of rubble were dumped on top of the sand layer to raise the breakwater crescent from 4 m below to approximately 4 m above the sea. Sloping layers take out force of waves as it comes into contact with the walls. The protection comes from the outer armour, which is made out of huge boulders of rocks with each rock weighing up to 6 tons. 5.5 million cubic meters of rocks were obtained from 16 quarries around the Emirates, which is enough to build 2 Egyptian pyramids. The rocks were piled on barges and instantly shipped to the construction site in less than 24 hours. Then, a floating conveyor belt operating all day and night, discharged the 40,000 tons of rock per day to the breakwater crescent. Rocks were selected by size and weight and specially positioned by cranes. Each rock was placed in such a way that they must interlock with the adjacent one to tackle forces of the sea. For safety precautions, frequent checks were performed to make sure the rocks in the breakwater are not drifting away. For this reason, divers were sent undersea to survey the ocean floor, every 27 m, looking for cracks and splinters in rocks or rock fatigue caused by strong waves. After successfully placing the rocks, finding the right sand to be placed on the fronds was the next big challenge.

Dubai has big deserts but sand from the desert is not the most suitable type for construction because it is too fine and flaky. The solution was found in sea itself. Sand was dredged from three massive barren sea beds 60 nautical miles out of sea in the gulf. This sand is most suitable to work as it was coarse, dense and resistant to wave impact. The sand was dredged by the Belgian company Jan De Nul and the Dutch company Van Oord, and was sprayed using dredging ships. The sand was dredged at very high speeds at 10m/s. This process, known as the rainbowing process, is when a dredging ship propels sand from the ocean floor and forms a high arc in the air. After the rainbowing process, the sand rises 4 m above water.

Sand placement was guided by at The Palm Jumeirah by Differential Global Positioning Systems (DGPS) allowing for an error of less than 0.39 of an inch. The way this works is that five men walk around the entire island daily in the hot temperature and high humidity levels, carrying the gadgets behind their backs, and receive signals from the Prince of Dubai's own satellite system, located 676 km up in space. The height and position of the deposited sand is recorded and reveals the coordinates where precisely, the dredges should make additional deposits.

3. CONCLUSION

The construction of The Palm Jumeirah has opened a new and innovative approach to mankind. The population of the world is increasing day by day and it is a great concern how the coming generations will survive as the land is limited for inhabitants. Now the engineers have shown that land reclamation can be done and the area of water can be used for the residential purposes. This paper has shown how this daunting task has

been completed. In the end the author proposes such projects for India as the population is growing fast and the land is becoming short. Also such structures can bring tourism and help the economy of the nation.

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