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Application of Geo Informatics in the Construction of Floating Airport (FLAIR)

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ABSTRACT - The unprecedented growth of air travel and the development of larger and faster aircrafts demands new approaches to aircraft design. Real estate within reasonable proximity in large cities is expensive, if at all available and the acquisition of land is becoming central and certainly the most time consuming aspect of airport planning. In addition to this neighboring communities mount powerful objections to the danger, noise and pollution which to some degree are un-avoidable by products of large airports. Thus, as an alternative viable solution one must consider airports located in seas or large water bodies. Using radar images & remote sensing for locating the site in a shoreline and constructing an offshore airport for the city of Mumbai in the Arabian Sea is the purpose of this paper. The Arabian Sea has various profound depths and structure like airport requires a depth level of 200 to 500 feet. Sea tides and seismic activity plays a vital role hence radar data can be used to analyze tide patterns and seismic data of the Arabian coast subsurface will help us to acquire enough data about the shortcomings of this project. Also surrounding industries, marine flora and fauna and the urban busy life of the Bombay coastline has to be kept in mind which can be seen precisely using satellite imagery and stereophotogrammetry of the city hence a suitable site for construction can be located. Floating airport requires the use of submerged buoyancy chambers as their foundation support by means of vertical columns below the surface which diminish the buoyant volume of the structure subjected to wave motion. This buoyancy tends to raise the platform and elevate the chambers to the surface of water and to restrain the structure vertically and laterally, taut mooring cables and anchorage system will be used. Hence Civil and Geo Science engineering emerge for this project. The concept of a Floating airport was first proposed in 1934 by E.R. Armstrong as "Seadrome" and it may be used in the upcoming project of London Airport constructed on River Thames.

Keywords : Floating airport, Stereophotogrammetry, "Seadrome"

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1.0 INTRODUCTION:

It is often said that managing an airport is like being governor of a city. Similar to a city, an airport is comprised of a huge variety of facilities, systems, users, workers, rules, and regulations. Also, just as cities thrive on trade and commerce with other cities, airports are successful in part by their ability to successfully be the location where passengers and cargo travel to and from other airports. Furthermore, just as cities find their place as part of its county's, state's, and country's economy, airports, too, must operate successfully as part of the nation's system of airports. So does our topic is to construct an airport portraying as the icon of our country India. Thus geo informatics and civil engineering comes into play for this action.

Now according to the demographic statistics of India till 2012, Maharashtra is second populous state with more than 112 million people and its capital, Mumbai, is the densest city on the planet earth with the population of 20 Million people and it is the financial capital of the country afterwards generating half of the Indian foreign trade.

Eventually India is going to surpass china and become the fastest growing economic country in the world but despite of economic opportunity India's infrastructure is very crumbling. Mumbai's economy is growing very rapidly but Infrastructure of this city is very challenging. So Mumbai is in desperate need of up gradation in Infrastructure facilities.

Why Mumbai?

Since it has the high density of population on planet earth and it is devoid of open space. Moreover it is situated at western coast of the country hence as an alternative viable solution one must consider airports located in seas or large water bodies. Now apart from the ongoing project of Chhatrapati Shivaji International Airport which will be one of the mega structure in India and the solution to the infrastructure of mismanaged Mumbai. This paper gives us chance to improve not only Mumbai but any other coastal city in India.

Using radar images & remote sensing for locating the site in a shoreline and constructing an offshore airport for the city of Mumbai in the Arabian Sea is the purpose of this paper.

2.0 Study Area:

The study area is divided into two categories:

Site location and shortcoming analysis using photogammetry and radar imagery Basic structural study and design of the foundation of the floating airport

[3.0] Application Of Remote Sensing In Site Location:

Remote sensing and photogammetry have now evolved to become a necessity these days because of its wide applications in urban planning, communication systems, hydrocarbon

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exploration and geospatial studies.

In recent times using remote sensing for site location has become an integral part of urban planning and management. Hence we use remote sensing and infrared images to locate the site for the offshore airport.

We analyze images representing depth levels of the Arabian Sea, wind data sea temperature and pressure to find a suitable location for construction There are many shortcomings execute such a project on the Mumbai offshore region.

Firstly analyzing the depth of ocean levels as an airport occupies a lot of area hence it is very important that the site is deep enough so that enough space is available.

Also we know that the government limits construction to 200 nautical miles from the shore. So finding a particular site within 200 nautical miles is very important.

Tides play a very vital role here. Things like natural calamities in the ocean and shore line cannot be overlooked. During the monsoon the sea is turbulent hence we must make sure that the airport sits steady.

We also cannot move to away from the shore line as connecting routes from the airport to the shores cannot be too long. This will make construction very risky and costly.

3.1 Study of the Western Coastline of India.

India has a 7,500 kilometer long coastline which has been undergoing morphological changes throughout the geological past. The sea level fluctuated during the period of last 6000 years and recorded marked regression during the period between 5000 and 3000 years before present. The present coastal geomorphology of India has evolved largely in the background of post glacial transgression over the preexisting topography of the coast and offshore.

Though there are large number of rivers bringing enormous quantities of sediments along the west coast there are no deltas probably due to the high energy condition of the coast.

This is an advantage for the project as the coastline of the Arabian Sea is rigid.

Also the entire Deccan region is slightly tilted downwards towards the east coast. Hence making the western coastline and range higher than the eastern. Also the coastline in the west is narrower than the coastline in the east.

The west coast of India is further divided into the Gujarat coast, the Maharashtra coast, Goa and Karnataka coast.

The Maharashtra, Goa and Karnataka coast are characterized by pocket beaches flanked by rocky cliffs, estuaries, bays and at some places mangroves.

3.2 Studying images showing depth levels on the Arabian sea coast

Studying depth levels will help us locate a suitable location for construction.

We observe the change in depth levels on a daily basis to find the data.

First we observe the data on Tuesday 12th March 2013. (Fig. 1). In this image it is shown that the areas near the Bombay offshore region is deep having a depth of 8 to 10 ft on an average. Then we observe the image of 13th March 2013 on Wednesday. (Fig 2). Even in this picture we can see that the coastline has a good depth. Wednesday 9pm (Fig. 3) shows that there is high tide in the area hence the shoreline is deep. We now observe the image for Thursday 14th March 2013 (Fig 4). In the same way we show the image taken on Friday (Fig. 5). In the same way we show on Saturday (Fig 6). After observing all the above data we find one thing in common i.e. the Mumbai offshore area is always deep compared to other parts especially the northern and central portion of the Arabian Sea.

Hence it is ideal for construction of the airport. When tides are high it is more suitable as depth is those areas increase. Also we see that the height of the wave usually does not exceed 14 to 16 ft approx. Hence it is pretty safe to construct the airport.

3.3 Studying images showing wind charts of the Arabian Sea coast.

Wind plays a very vital role in site construction. Strong winds act as a barricade in the airport as weather problems create problems in flight patterns. Flights will not be able to land and take off if there is turbulence.

Hence we analyze wind images to find out a safe location for the site.

First we analyze the image for Monday 18th March 2013 (Fig 7) and the data for 19th March 2013 (Fig 8). This wind map data shows that the Bombay offshore region experiences a beaufort force of 4 which indicates that it is a moderate wind velocity 13 to 17 mph.

Now we see the image for Wednesday (Fig 9), for Thursday (Fig. 10), Friday (Fig 11)

Now analyzing all the data we see that on an average the wind velocity has a beaufort force of 4 to5 which is 13 to 14 mph. This is moderate wind speed hence it is an ideal condition to build an offshore airport in Bombay offshore.

3.4 Studying the images for temperature in Bombay offshore region

Studying temperatures in different zones is important especially the Bombay offshore region where the airport is presumed to be constructed.

Fig 12 shows that temperatures in the Bombay offshore region are usually 32°C. This proves that the conditions are ideal for building an offshore airport in Mumbai.

4.0 Design Of Floating Airport:

The unparalleled growth of air travel and the development of larger and faster aircrafts, demand new approaches to airport design. Many existing facilities are currently filled to capacity but sometimes expansion is not possible. Hence one must consider an airport located on the sea or in other large bodies of water.

The advantages of the locating airport on Mumbai Seashore:

Expansion can be done easily if needed in future

Tourist attraction and a state of art technique

Elimination of danger, noise and air pollution to populated area

The idea of such a stable platform has already been originated since 1934 by E.R.Armstrong. Since that time floating airport have been investigated but not been implied on earth till now. Armstrong proposed the idea of using buoyancy chamber which supports the platform constituting runway, taxiway and other facilities what an airport must have. The submerged buoyancy chamber is located at a distance below the surface which places it for all intents and purposes, below the wave base and, therefore, minimizes the buoyant volume of the structure which is subjected to wave motion. Only the parts connecting the submerged buoyancy chamber with the deck are subjected to buoyancy variation due to waves. This idea, by reducing the bending in the hull makes the construction of the extremely large floating platforms practical and feasible.

In addition to this the buoyancy chambers which is submerged below the wave base, substantially reduces heaving motion of the platform. It is assumed that structural stability is achieved by placing chambers at a sufficient depth below the surface.

The platform position is going to above the surface at a distance to ensure that deck will not fail in severe sea condition and connected by vertical columns to buoyancy chamber located below the wave base. The deck and buoyancy chamber combination together will all super imposed has large positive buoyancy. This buoyancy then tends to raise the platform and elevate the chambers to the surface of water. The whole structure is vertically restrained by means of taut mooring cables. These cables are continuously under large tension so we must provide pre-tension foundation system consist of a bottomless watertight chamber filled with compresses air, used as a base from which construction work is carried out underwater called caisson foundation system. This type of foundation is possible into high depth of water. At the same time, highly prestressed taut cables (tendon) stabilized the platform vertically and laterally. This type of tensile foundation makes it possible to place the platform into depth of water of 200 ft or more and Arabian Sea average depth is far greater than it (around 600 ft) and maximum depth of Arabian sea is 15,000 ft so it is possible to construct this structure it.

4.1 Configuration

Superstructure and deck- approx. 26 ft above mean water level.

Vertical columns and bracing

Buoyancy chambers

Mooring cables

Mass Anchors (located at depth of 400 ft an beyond)

The airport is designed to satisfy the requirements of current Boeing 747 aircraft with the maximum load i.e. take off weigh around 4,50,000kg. This airport also meets the needs of general requirement including harbors, hangers, terminals etc. Now all the basic design drawing/ architect including taxiways, runways, and aprons can be made in any manner according to drawings and pattern given by the ICAO (International Civil Aviation Organization) but mention below is just the designing of airport.

4.2 Design Philosophy

The airport is designed to be operational in severe sea conditions. The structure will survive winds of 130 mph and 40′ high waves and according to statistics of Arabian Sea, it average wind velocity varies between 13 to 14 mph. The design itself can be adapted to more severe conditions, that is, for higher waves by increasing the height of the platform above the sea level and increasing the depth of the buoyancy chambers. The anchoring will withstand currents and tides encountered in offshore locations.

We have taken the maximum loading on the platform by the Boeing 747 jet i.e. 4,50,000kg while take off. And we considered slab as uniform distributed loading slab. According to the standard dimensions of airport drawings provided by ICAO, the length of the slab is 150 meter (492 ft), width is 125 ft (between 100-150 ft) and thickness is 21 inches (1.75 ft).

We have made a proposed structural design for the airport on the stadd.pro which we have attached at the end of the paper.

5.0 Conclusion:

From the above data, analyzing the tide, wind and temperature maps we conclude that Bombay offshore is an ideal region for construction of the airport. The wind data is ideal which is 13 to 14 mph and temperatures being great with depth also adding to the proof that such a thing is possible. This is also an example to show how beneficial remote sensing is for urban planning, development and management.

If any calamity or changes occur in these regions remote sensing and weathering data can tell us before hand and hence immediate precautions to meet any such natural calamity can be thought and implemented.

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1. Fig11-http://magicseaweed.com/Arabian-Sea-Surf-Chart/41/#?chartType=TMP&_suid=1363366723357010761759171737095
2. Fig. 1 to fig. 5 - http://magicseaweed.com/Arabian-Sea-Surf-Chart/41/
3. Fig.6 to fig.10-http://magicseaweed.com/Arabian-Sea-Surf-Chart/41/#?chartType=WMAG&_suid=1363363737877030433105063364296
4. FLAIR report by Paul Weildlinger, Consulting Engineers.

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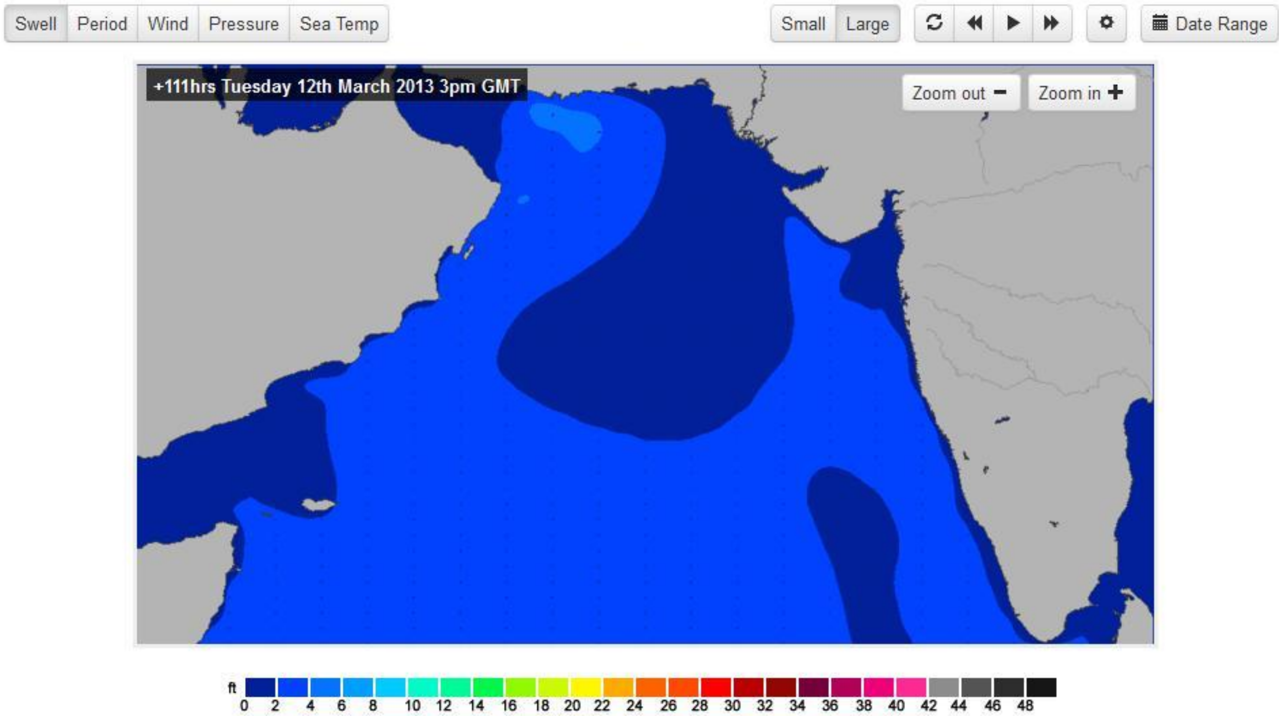

Fig. 01

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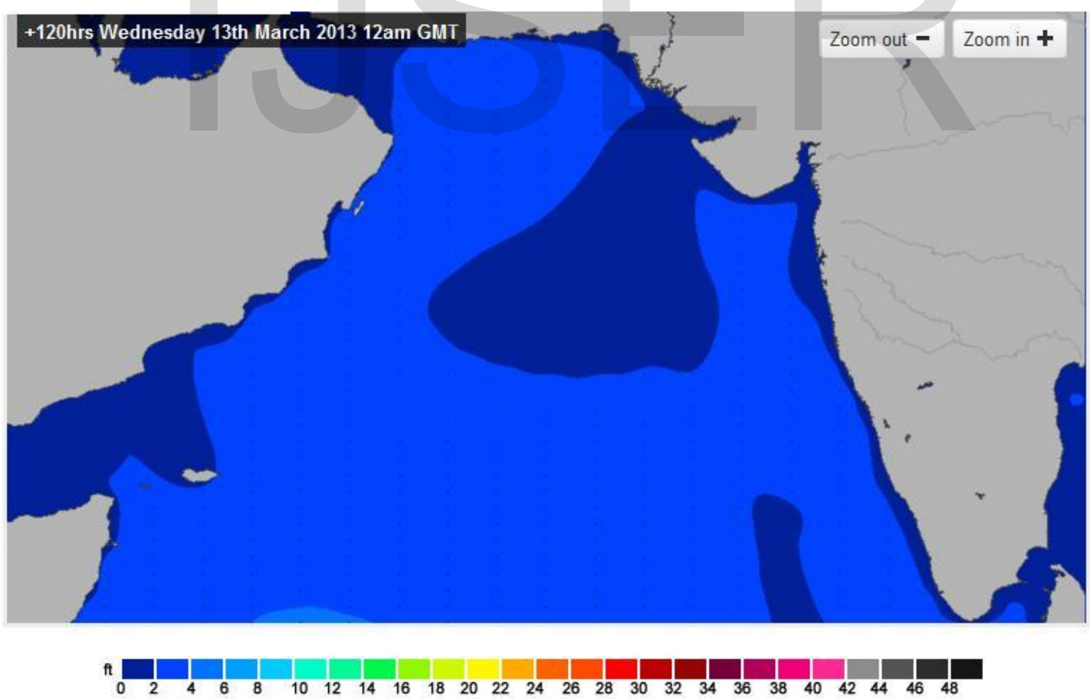

Fig. 02

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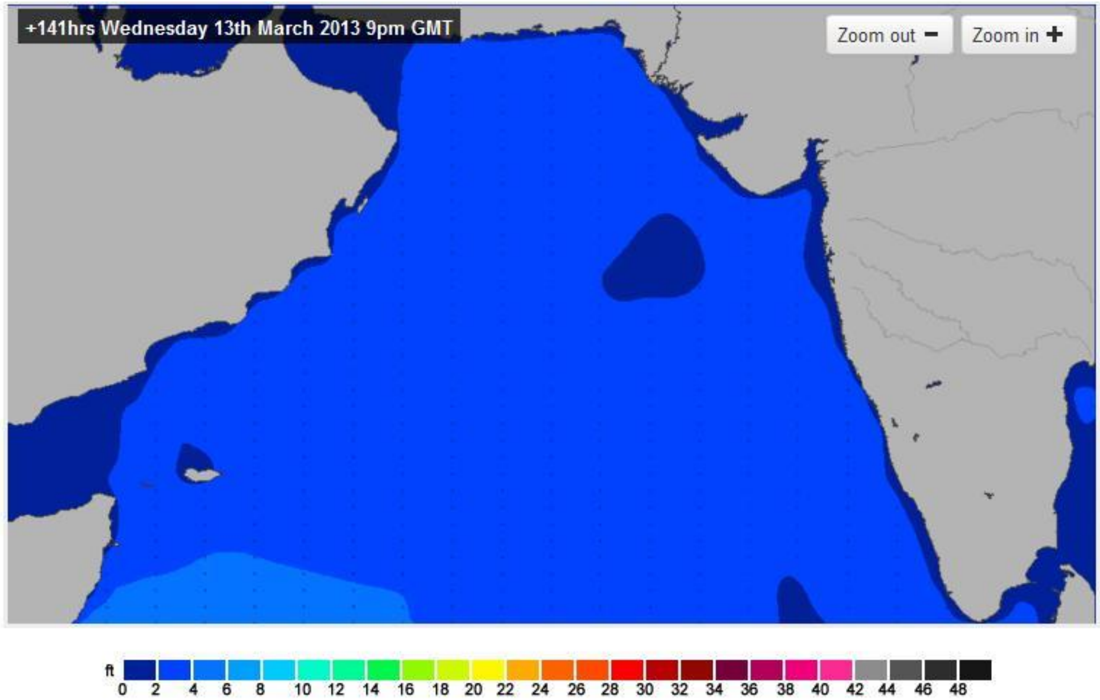

Fig. 03

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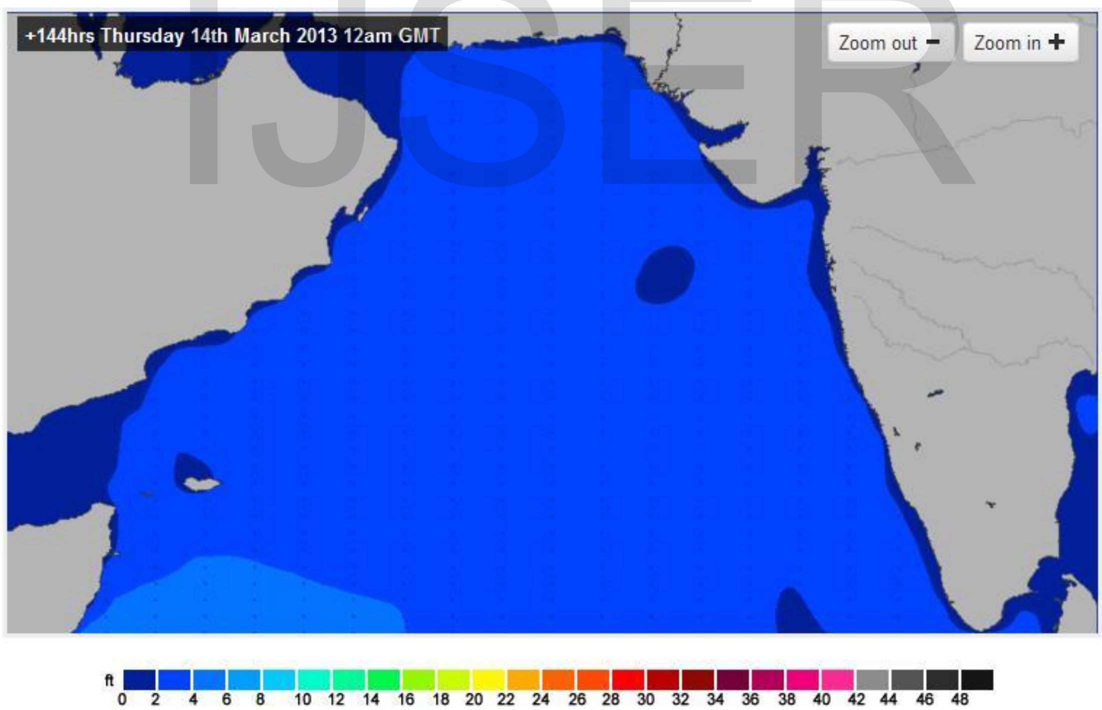

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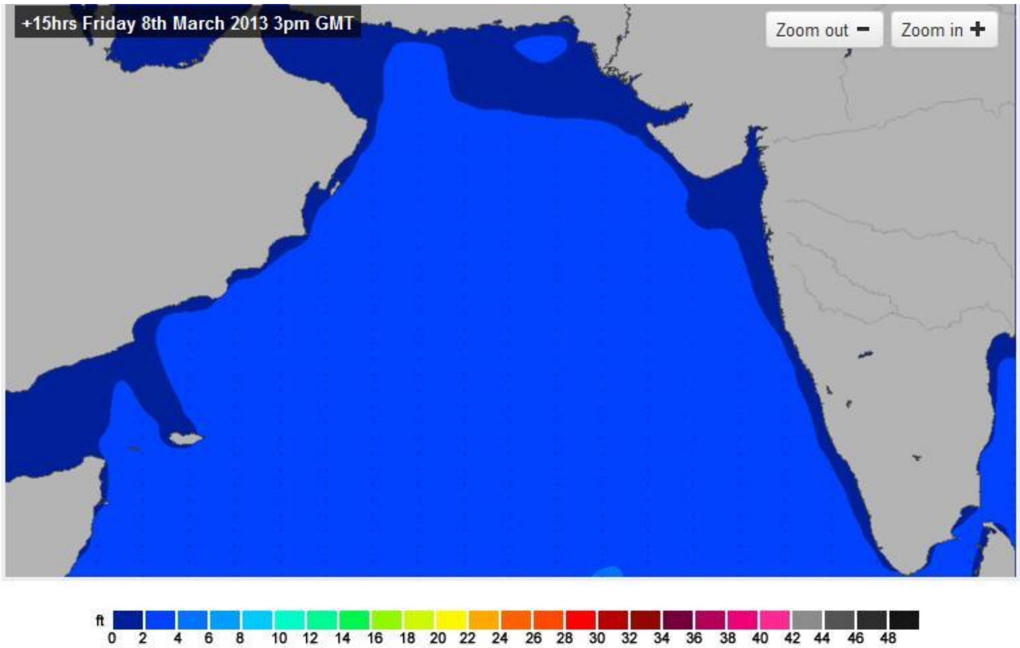
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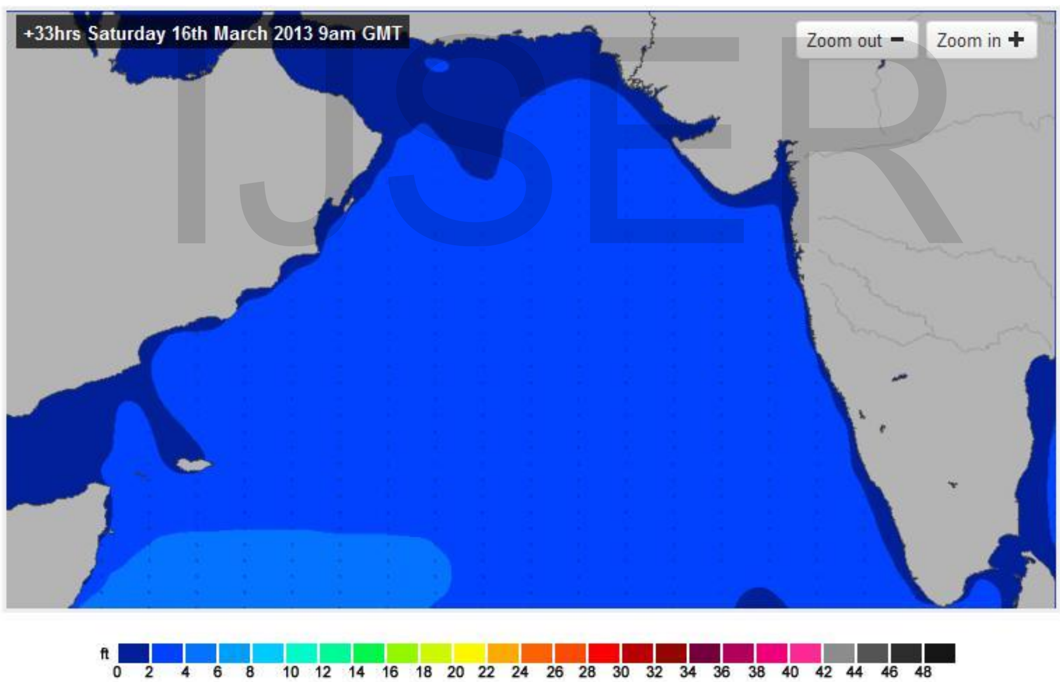
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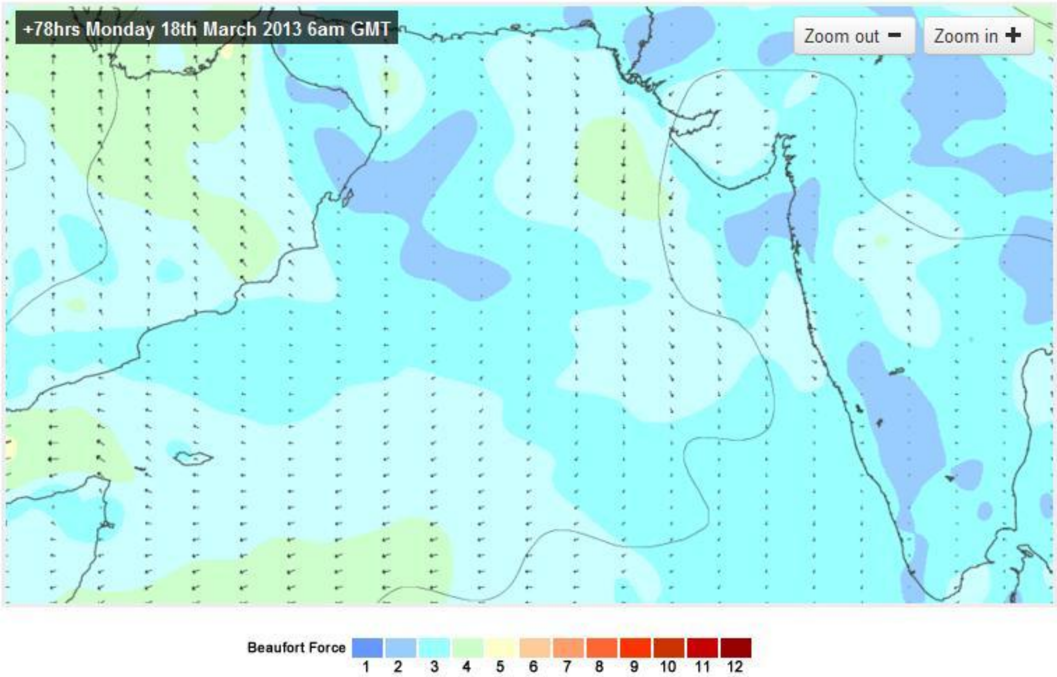
Fig. 06



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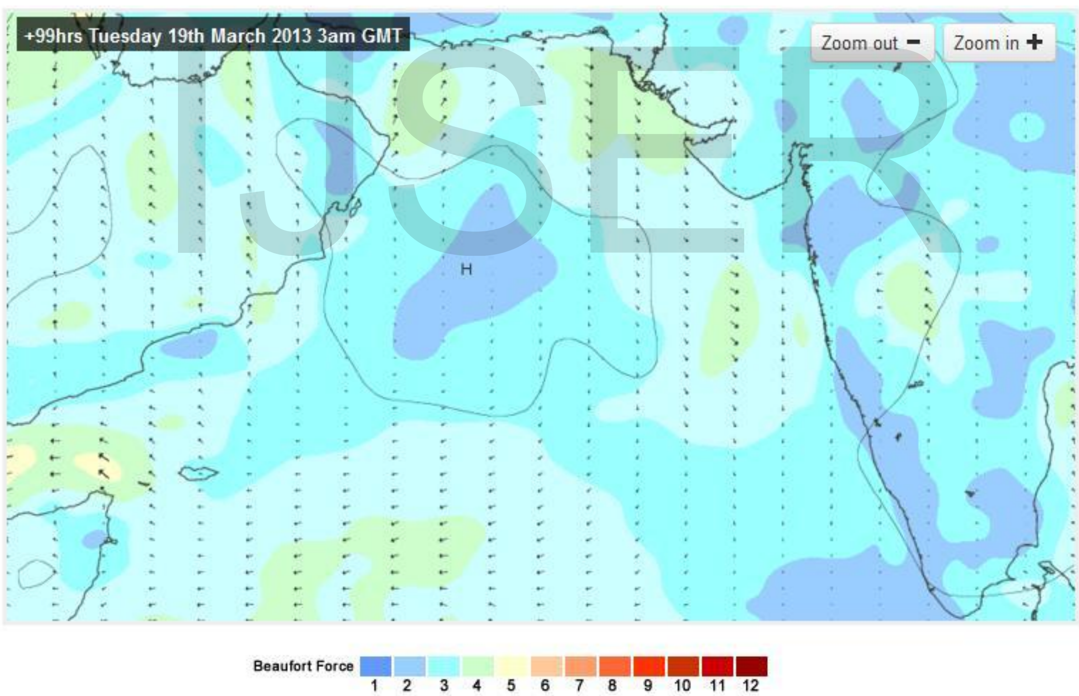

Fig. 08

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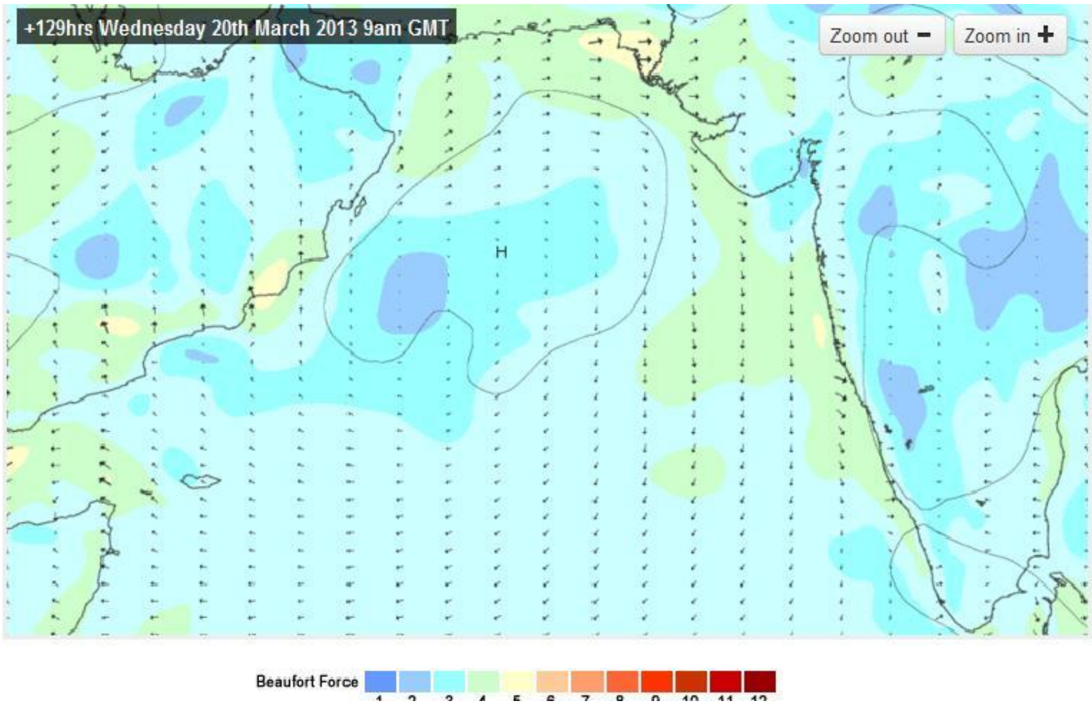

Fig. 09

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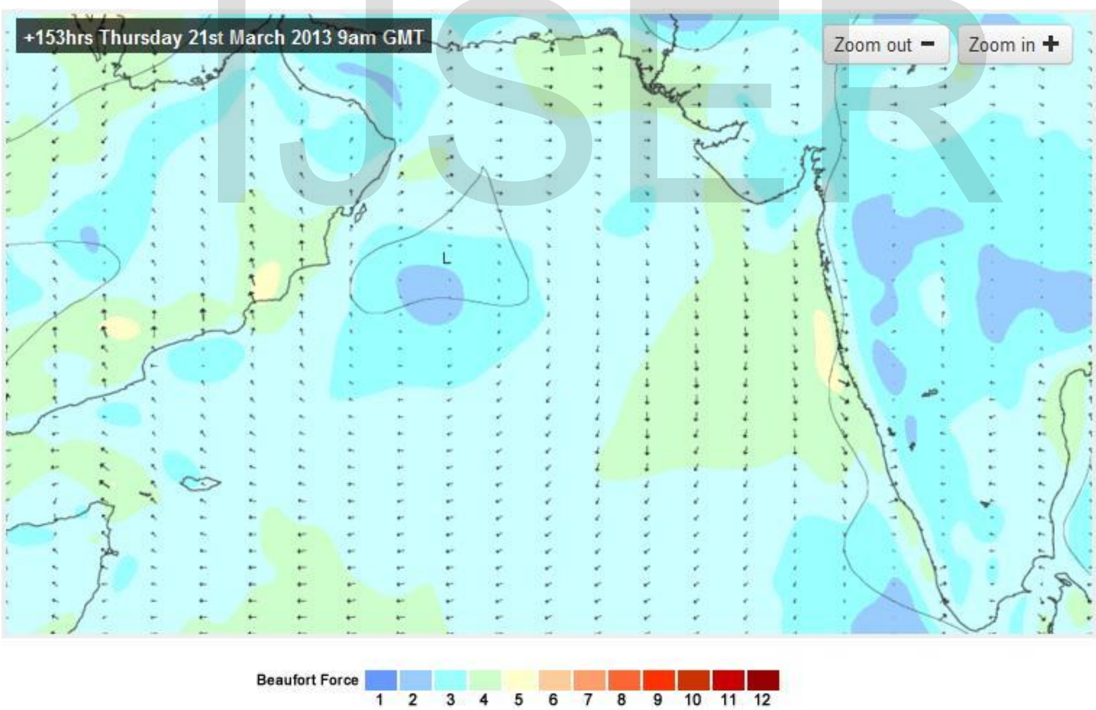

Fig. 10

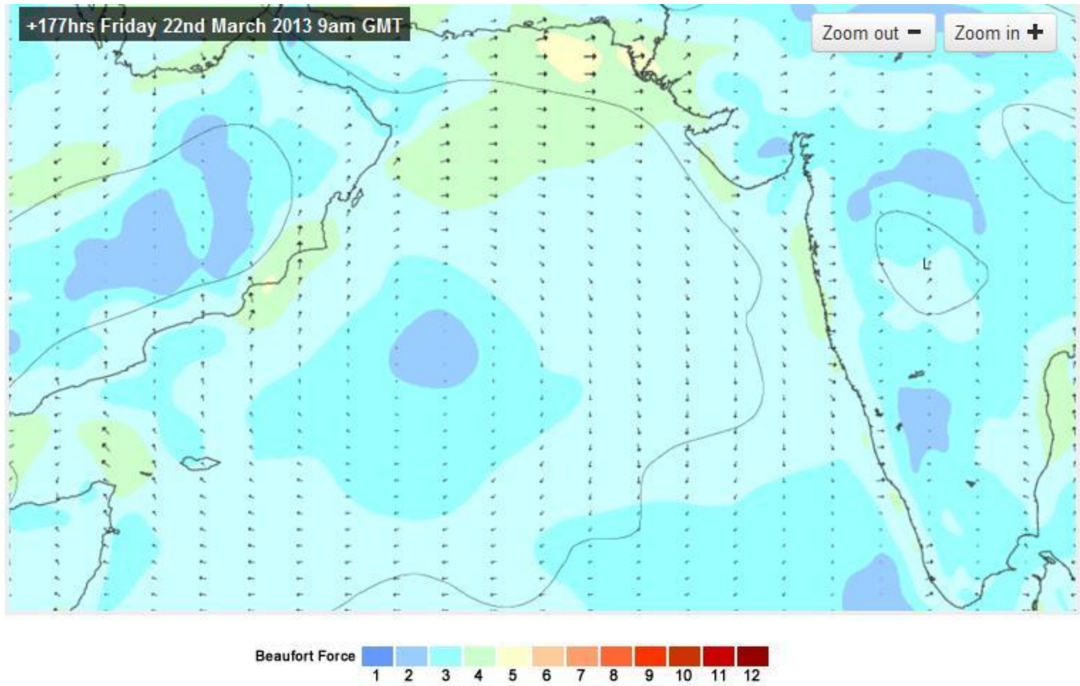

Fig. 11

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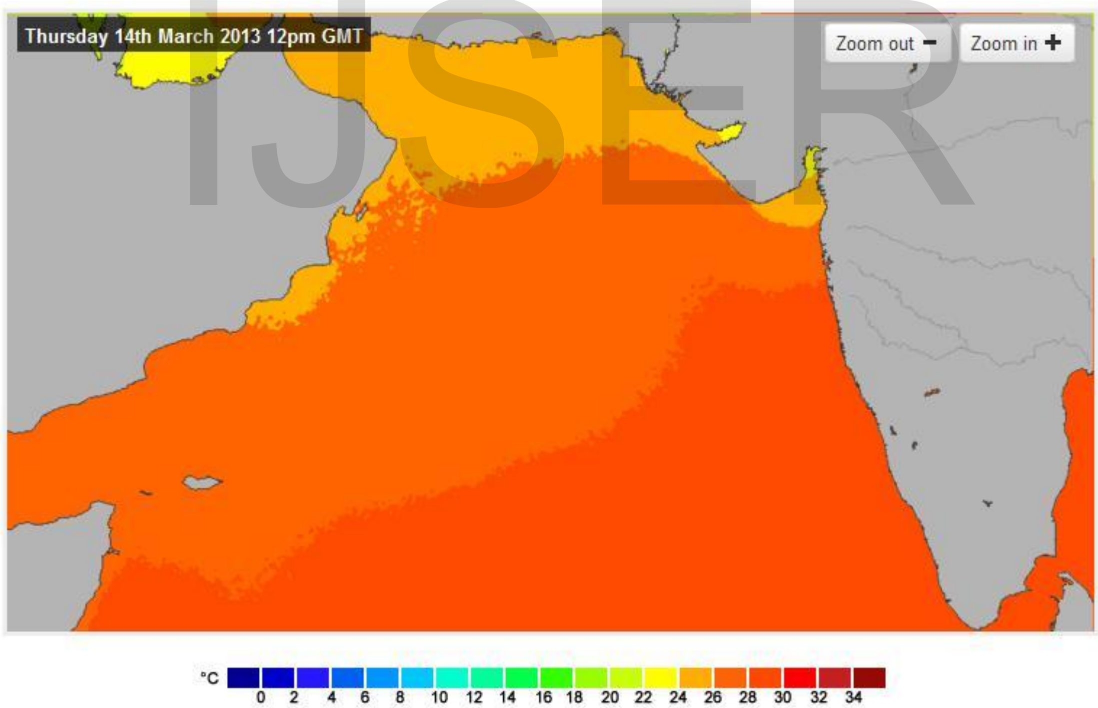

Fig. 12

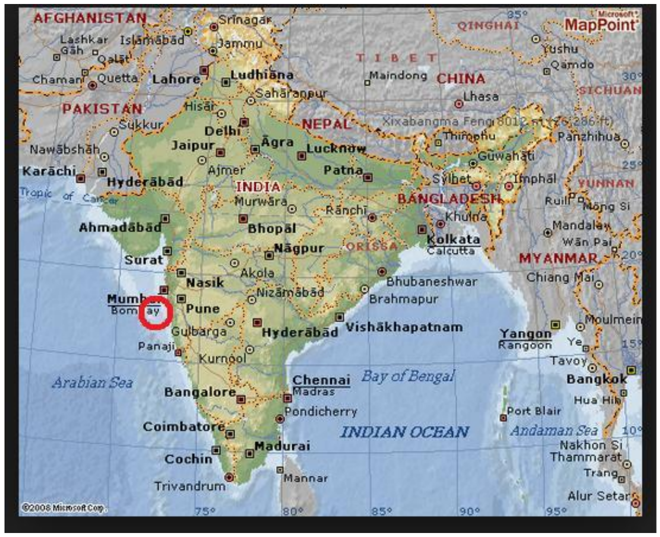

Fig. 13 India and its environs

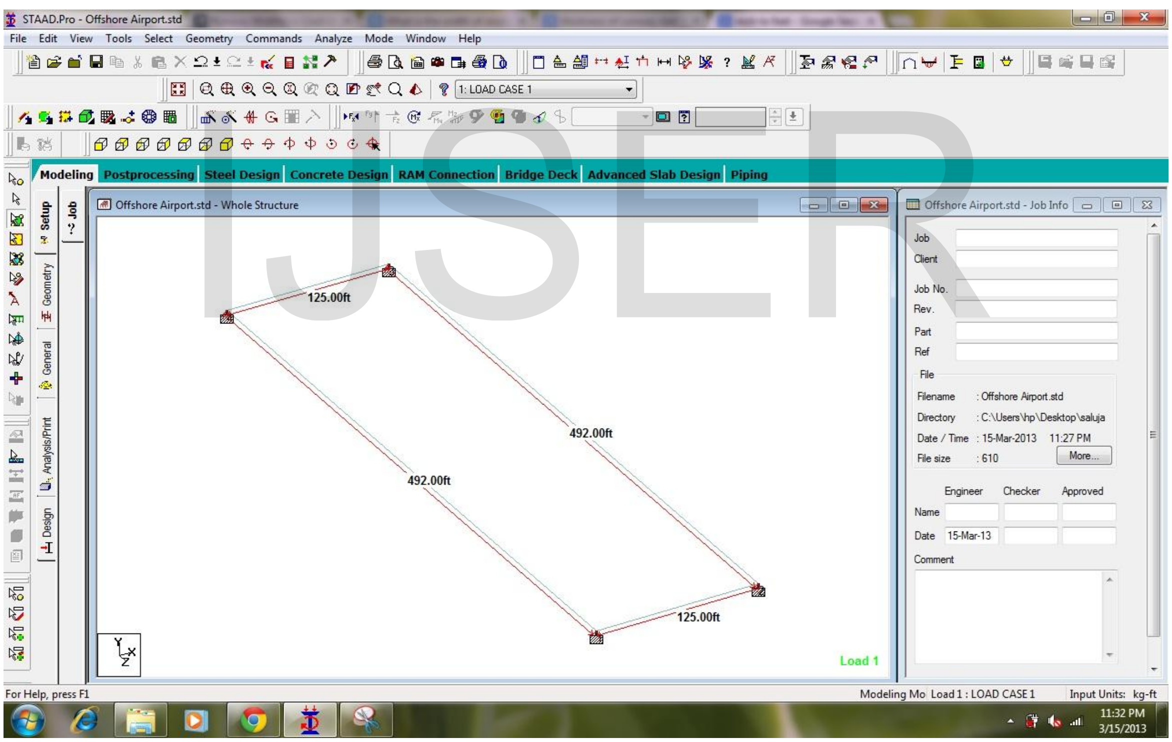

Fig. 14 The dimensional view of the structure.

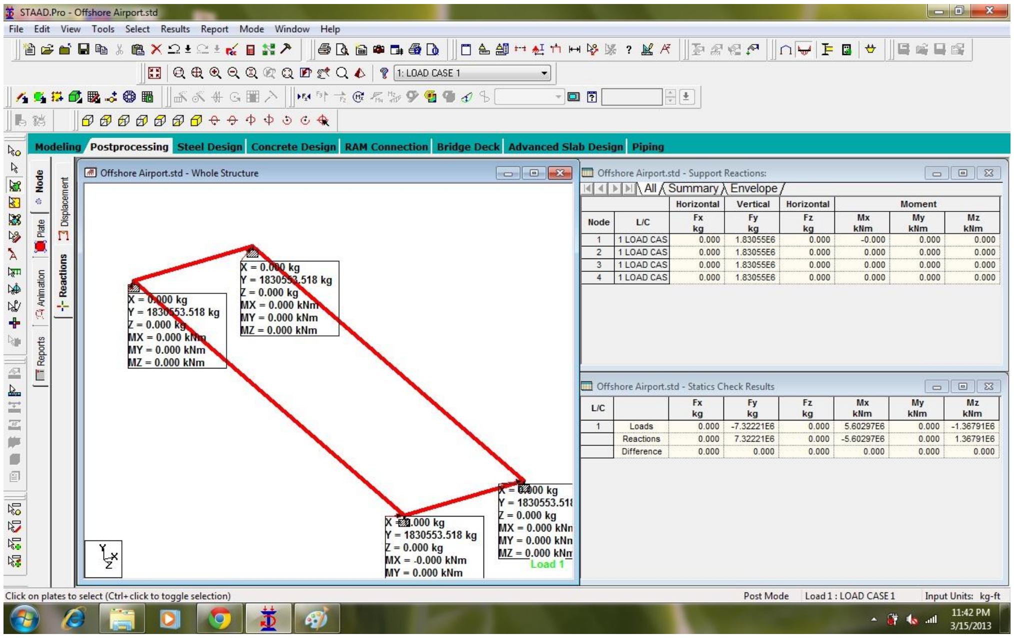

Fig. 15 The post processing view of the structure.

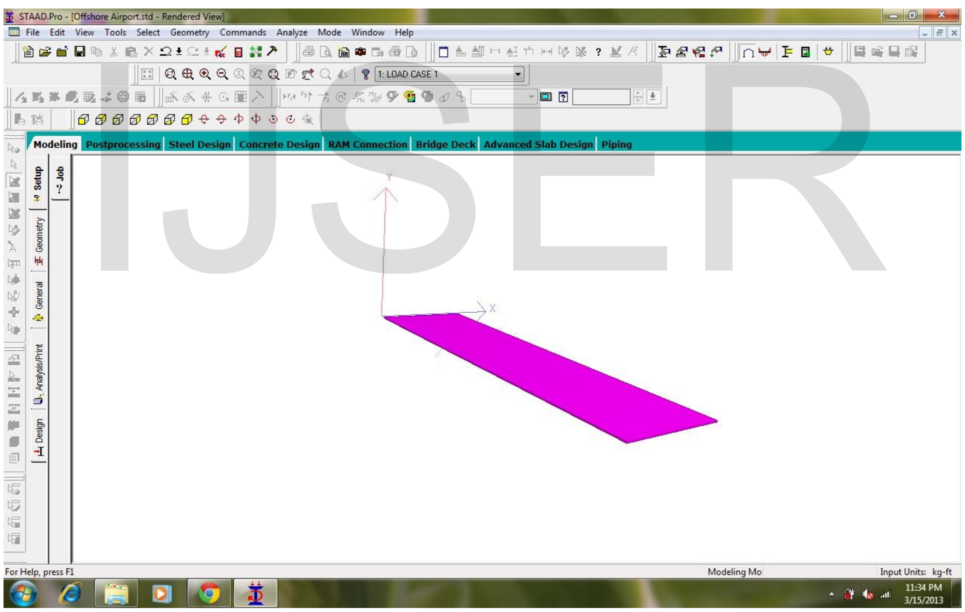

Fig. 16 The rendered 3D view of the platform.

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