Designing The Lighthouse Building Based On The Location

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Abstract - **When come to waterway, Lighthouse plays a very important role for the water transportation like Boat, Ship and Submarines. This paper shows the planning, analysis and design of a lighthouse building based on the location. The place of construction takes place in Point Calimere, Kodiakkarai, Nagapattinam district, Tamil Nadu and it is surrounded with many good vegetations, harbours, and Wildlife sanctuary. This location makes exactly a right turn corner in coastline which may leads to accidents. The estimated horizontal light distance is 13km. Analysis and design of Lighthouse building was done as per IS code 456:2000, IS 875 part 3 1987, 1893 part 4 2005, IS2911 (part1/sec3):2010. Light house plans prepared with the help of AutoCAD software and analysis was carried out with the help of STAAD.PRO and STAAD Foundation Advanced V8i software.**

keywords - **Lighthouse, Location, Coastline, Horizon distance, Software.**

I. INTRODUCTION

The lighthouse plays a huge role in coastal world. It helps to navigate the marine pilots, and also indicates the dangerous coastlines, reefs, safe entries to harbours. The lighthouse depends on location and purposes, it acts as keeper's living quarters, boathouse, fuel house, telecommunication, fog signals, etc. At the top of the lighthouse, lantern rooms are provided for emits the LEDs arrays and storm proof ventilator to remove the fog and smoke. Some ancient lighthouse has declined due to maintenance expenses and replaced by modern electronic navigational system. Lighthouses are usually painted with contrasting colour patterns such as white and red or white and orange which makes more visible against sky.

II. FACTORS TO BE CONSIDERED FOR LIGHT HOUSE DESIGN

1. DESIGN CONSIDERATION

The design of lighthouse should withstand all the type of natural disaster like storm, earthquake and tsunami. It should be constructed in proper place to navigate the pilots, to warn boats from dangerous areas, to control traffic in sea, guide ships into harbour or back out to sea and to warn the sailor dangerous like rock and coastline.

a) BASED ON COLOUR

Lighthouse is similar in pattern and painted in unique pattern so sailors can recognize in daylight like Daymark in Scilly. The black and white colour in spiral pattern as in Cape hatteras Lighthouse in North Carolina.

b) BASED ON DESIGN

For effectiveness of light the lamp must be as high enough for sailor to be seen before they see the danger. The minimum height of the lighthouse is calculated by trigonometric formula Horizon. ($D = 1.17 \sqrt{H}$) Where (H) is height above water in feet and (D) is the distance to the horizon in nautical miles. This horizon formula is used to determine the height for required horizontal light emitting distance.

c) BASED ON SHAPE

The lighthouse is found in many shapes like circular, square, pentagon, hexagon and octagon in cross section. Most of the light is preferred to constructed in circular. The circular lighthouse reduces effect of wind and wave force. When the wind and wave hit the structure with the full force it evenly disperses it across its side.

d) BASED ON SIZE OF STRUCTURE

There are two size of lighthouse structure one is smaller and another is larger. Based on the purpose of use they can be categories. If the lighthouse is only used for entry and exit of harbour then small lighthouse is recommended to constructed example Horton point light in New York. If they are using a lighthouse for indication of coastline, then they are required to construct larger size of lighthouse.

e) BASED ON MATERIAL

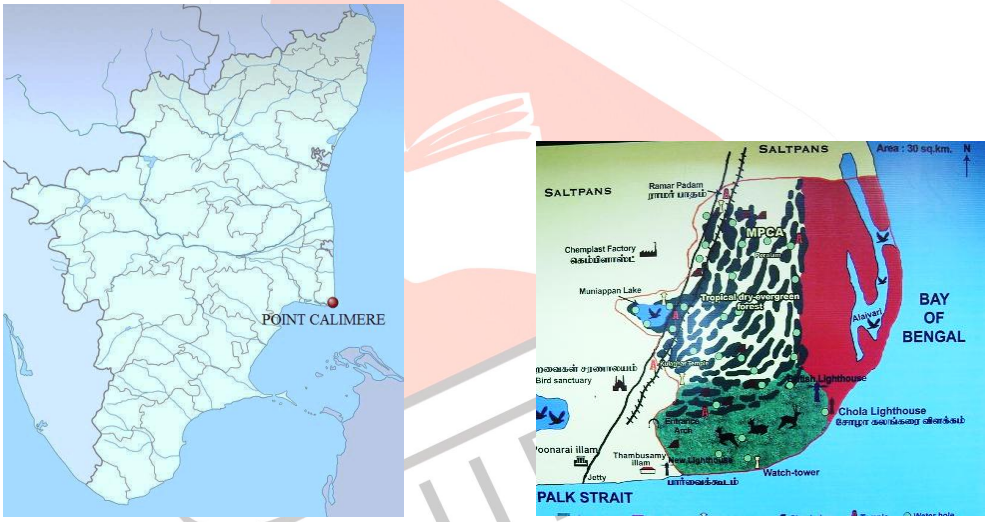
The lighthouse is build using many different kinds of materials such as, Wood, Iron, Steel, Brick, Concrete. In historical period lighthouse is usually build using bricks and wood. As the technology getting advanced, they started using prefabricated skeletal iron and steel structures like Finns point range lighthouse in New Jersy. The concrete and steel are the most widely used materials for lighthouse now a day.

f) BASED ON CONVENTIONAL IN SEA

When water is too deep for construction of the lighthouse in sea floatable material is adopted for lighthouse like lightship Columbia. In some cases, lighthouse is get damaged by ice in cold climate in such condition screwed piles to reduce the damage from ice like in Orient point light in New York. Some lighthouse are fixed light platforms which is used to offshore oil exploration like Ambrose light in entering and departing the port of New York and New jersey.

g) PLACE OF CONSTRUCTION

The place of construction of lighthouse is in Point Calimere which is in Kodiakkarai, Nagapattinam district, Tamil Nadu. Point Calimere is a low headland on the Coromandel Coast. It is the apex of the Cauvery river delta, and marks a nearly right-angle turn in the coastline. The Point Calimere is also one of the tourist places in Tamil Nadu. This Point Calimere is exactly located 9km from Vedaranyam. The antiquity of the region is Kodi Kuzhagar temple of Chola period. Also, a historic landmark in Point Calimere was Chola lighthouse. This Chola lighthouse is used for navigation purpose for some years. But in 2004 tsunami the Chola lighthouse is completely destroyed. Because it was built over 1000 years ago with bricks and mortar. The point is surrounded with some good vegetations and it also has Wildlife sanctuary (Point Calimere Wildlife sanctuary Kodiakarai). A custom office is also situated 7km from point Calimere. This custom office is used for patrol and inspection purpose of Ships, Hovercraft, Submarines and Boats to protect the coastline. Sometimes the area of the Point Calimere is 30. sq.km.



a b

Fig 1: (a) Point Calimere location and (b) Vegetation's

2. SITE INVESTIGATION

The lighthouse of our project is constructed in between the Chola lighthouse and the Office of customs. The lighthouse of our project will be placed in 2.2km away from the Chola lighthouse, 3km away from the Office of customs.

a b

Fig 2: (a) Site investigation (b) New lighthouse location

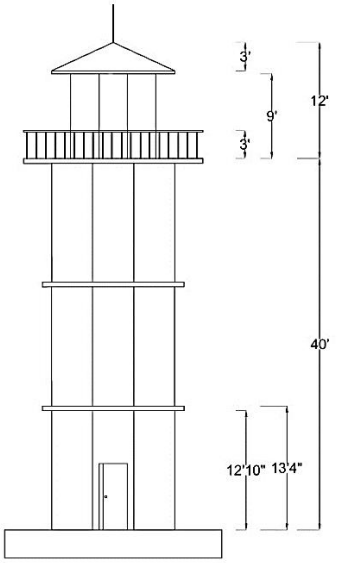
3. SITE BENEFITS

The Lighthouse location from will give many benefits for the Point Calimere. This new lighthouse is used instead of historical Chola lighthouse. It also navigates the customs office for sailors. The new lighthouse is constructed taller than the Chola lighthouse. This lighthouse will also warn the sailors form coastline because the point Calimere is the apex for Cauvery River and marks nearly right angle to the coastal line. The new lighthouse will navigate the container ship and sailor for caution. Therefore, by this new lighthouse the Point Calimere will be easily navigated and accidents will be reduced.

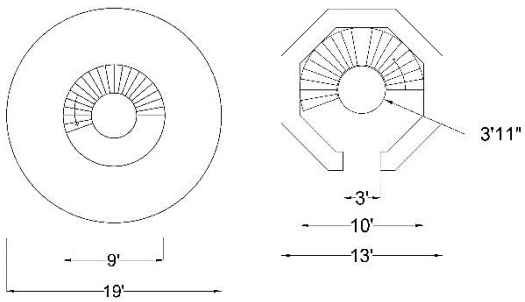
III. ANALYSIS AND DESIGN OF LIGHTHOUSE BUILDING

a. DESIGN SPECIFICATION

The first requirement for the design is height of structure. The height for tower or lighthouse is usually determined by Horizon formula ($D = 1.17\sqrt{H}$). Required horizontal light distance is 13 km or 7.01 nautical miles. Height of the light is Calculated as 40 feet from Main sea level Lantern room height is 12 feet, Structure type is G+3, Mix design taken as M30, Steel of Fe415, Structure shape as Octagon, Single circular column diameter as 3 feet, Wall thickness 1 feet and 6-inch, Slab thickness is 4-inch, Lightning rod length is also provided for length of 3 feet, Rails height is 3 feet.



Elevation of Lighthouse



Top and bottom plan of Lighthouse

Fig 3: plan and elevation detail of light house building

b. ESTIMATED RESULT OF HORIZON LIGHT COVERING DISTANCE

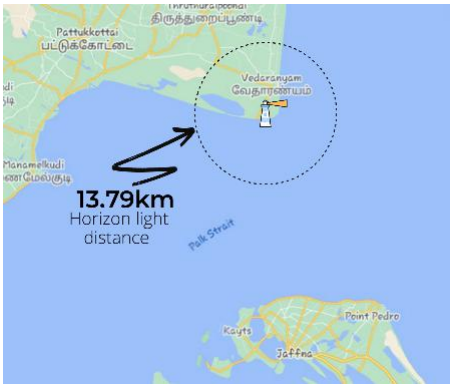


Fig 4: Estimated result

c. STADD ANALYSIS

All the elements of super structure in the lighthouse is analysed as per standard Indian code provision and analysed using STAAD.pro V8i software. Considered load are dead load, live load, wind load and seismic load. Dead load includes self-weight and lantern load. Live load consists of superimposed load. While designing wind load and seismic load we have to provide load definitions along with various load cases. The design of wind load in all directions based on Indian standard 875 part 3. The wind load has been calculated manually. The calculated wind load is 1.732 kN/m2.Likewise wind load, the design of seismic load in four directions based on Indian standard 1893 part 4 2005. In addition, the structure is also designed combination of load cases which includes Limit state of collapse and Limit state of serviceability based on Indian standard 456:2000. While considering the safety of the structure, the design is subjected to Limit state of collapse. The structure is located in coastal area. So, it should be safe against Tsunami and Earthquake forces. While considering the durability of structure, the design is subjected to limit state of serviceability Which deals with control on deflection, vibration, cracking and corrosion.

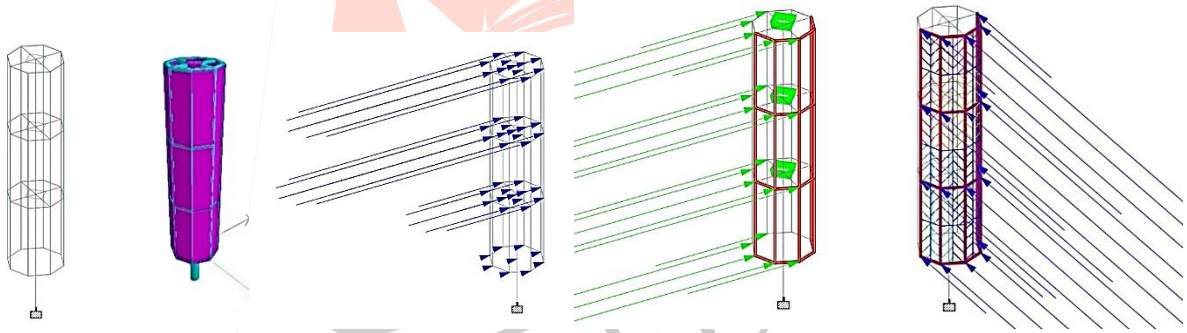


Fig 4: Stadd Model, 3D rendering and Load combination

d. DESIGN OF A LIGHT HOUSE BUILDING

Structural analysis is the logical investigation for stability, strength and rigidity of structure. The important need for structure analysis and design is to examine whether the structure is capable to sustain in all type of load conditions. The method generally using to design the structural elements is Limit state method and Working stress method. From the following method chosen is limit state method of design. The Ultimate aim of this method is to withstand all type of load and resist the structure throughout the life. It should also satisfy the serviceability requirements such as limitation, deflection and cracking. The result from the Limit state design is more effective than working stress method. referred the codes for this limit state method design are IS 456: 2000, IS 875: 1987, SP 16: 1980.

e. DESIGN OF BEAM

Provided beam details are Effective Span as 3200 mm, Yield Strength of Steel as 415 N/mm2, Characteristics Strength Of Steel as 30 N/mm2, Width Of The Support as 230 mm, Maximum Bending Moment as 45.62 kNm, Maximum Shear Force as 89.17 KN, Clear Cover as 30 mm, Effective depth as 260 mm, breadth of beam as 150 mm. Calculated result as 3 Bars of 16mm diameter bars as tension reinforcement and 2 Legged 10mm stirrups at 195mm center to center.

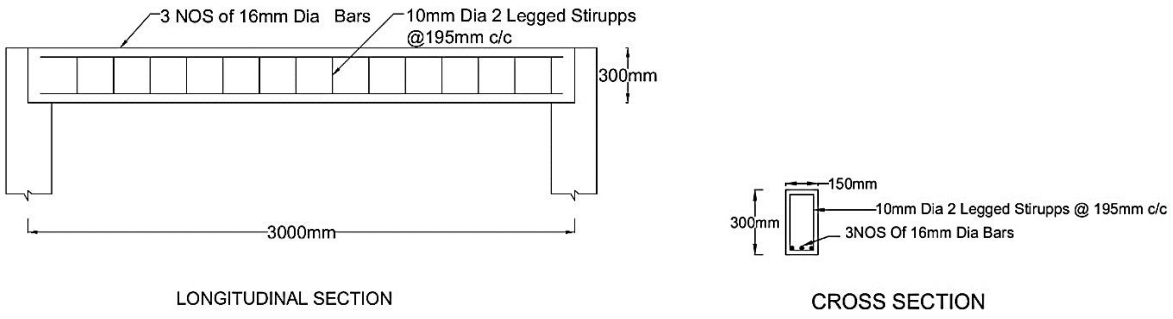


Fig 5: Longitudinal and Cross Section Beam details

f. DESIGN OF COLUMN

Provided column details are Axial load as 598.27 kN, Diameter of column as 600 mm, Effective length as 2700 mm, Strength of concrete as 30 N/mm2, Yield strength of steel as 415 N/mm2, Clear Cover as 40 mm, Calculated result as 33 bars of 20mm Diameter Bars as Longitudinal Reinforcement and also provide 8 mm Dia Bars @ 300mm center to center.

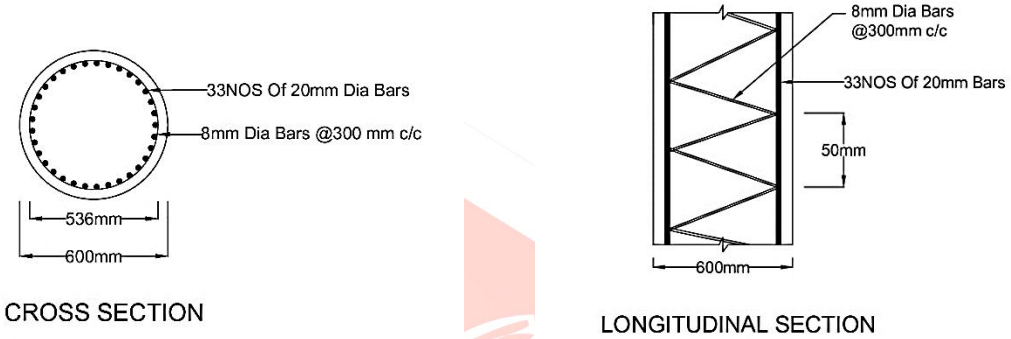


Fig 6: Reinforcement Column details

IV. FOUNDATION

The pile foundation is most commonly used for superstructure like tower, high raised building and complex structure Finally, complete content and organizational editing before formatting. Please take note of the following items when proofreading spelling and grammar.

a. PILE CAP DESIGN

Pile cap is designed in STAAD Foundation Advanced V8i. The Advantage of the software is it has 50 different design and has 5 different international codes. Number of piles is four, Pile diameter as 400mm, Diameter of bars as 16mm, Clear cover as 70 mm, Height of pile cap is 490mm.

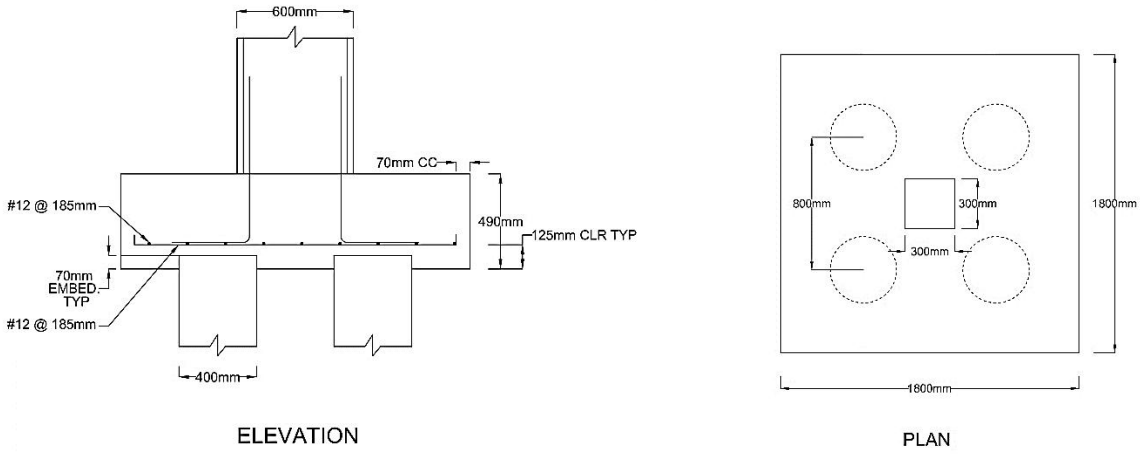


Fig 6: Pile cap details

b. DESIGN OF PILE FOUNDATION

Substructure is sorted as standard provisions of India, IS 2911 (Part 1/Sec3): 2010. Pile type taken as Friction Pile, the adopted pile height is 7m, Diameter of Pile is taken as 0.4m, Assume Clear cover as 65mm, provide 44 No of Longitudinal bars, Diameter of Longitudinal bars is 12mm, Type of Transverse bars taken as Helical, Diameter of Transverse bars is 8mm, Provide Spacing of Transverse bars as 200mm, mix design has taken as M30, Fe415 steel has provided.

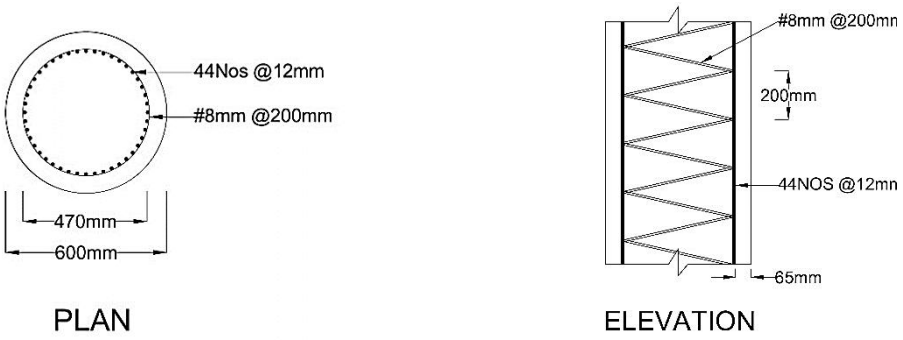


Fig 7: Pile Foundation details

V. CONCLUTION

The drafting of lighthouse building has been drawn by using AutoCAD and also analysis and design has been carried out by using STADD-PRO Software. The Lighthouse has been designed based on the Indian standard codes such as IS 456:2000, IS875:1987, IS2911 (part1/sec3):2010 and SP16:1980. This project is evaluated by considering the dead load, live load, wind load and seismic load acting on the structure. After analysing the lighthouse building, it is entirely proved that the structure is secured against all the loading conditions and other effects.

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