ANALYSIS MOORING SYSTEM CONFIGURATION OF SUBMERGED FLOATING TUNNEL

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ABSTRACT

Submerged Floating Tunnels (SFT) is a tubular structure that is submerged and floating in depth remains through the system of anchors consisting of a cable connected to the seabed. SFT structure imposed its own weight and is assisted by the buoyancy or uplift caused by water, cross sectin of the tunnel is designed so that buoyancy can overcome the structural weight and experienced a lift force that causes the floating structure. Fastening system (mooring system) also play a role which is to inhibit the SFT structure, minimize displacement and stress caused by environmental burden, such as earthquakes and hydrodynamic load that can aggravate the condition SFT structure in case of crossing the sea with SFT system. SFT will give a fairly small impact on the environment as it floated in the water, and with built using a modular system, the SFT (Submerged Floating Tunnels) can reach a distance long enough and does not cause pollution. Basically the same as the force that occurs archimides principle, where the objects are in the water to get a compressive force to the top. Cross sectional analysis SFT, will be modeled by 7 different models that have been in previous studies. The model's of SFT with steel cable to hold the structure in order to remain strong with the inclination selected. Analysis is done by modeling the triangle wiring configuration with different angle of incliflation cable. The analysis by comparing the test model were made earlier with prototype analyzed numerically. The expected structure did not undergo excessive deformation due to the environmental burden. Therefore, the structure of the SFT will be done with the Abaqus as finite element analysis. So, obvious deformation occurred in the cable. Therefore, it was expected to obtain the optimum angle of inclination was 54º.

Keywords: Submerged Floating Tunnels (SFT), Mooring System, Modeling, Configuration Cable Position

I. INTRODUCTION

Water crossing is one of the most important issues in this modern world of civil engineering, such as the crossing system is a demand in some places around the world. One of the traditional system that bridges the cable bridge, such as a suspension bridge or a cable stayed bridge, is the most suitable solution in cases where the distance to be traveled. In this case, the presence of crossing airdapat represent the state to take advantage of various terms, this is a new concept on the cable bridge is submerged floating tunnel (SFT) [1].

Submerged Floating Tunnel (SFT) is a tubular structure that is submerged and floating in depth remains throu gh the system of anchors consisting of a cable connected to the seabed. Tunnels are permanently subjected to its own weight and is assisted by the buoyancy caused by water, cross-section of the tunnel is designed so that buoyancy can overcome the structural weight and experience the power of volume directed upwards. The cable system also plays a role which is to inhibit the tunnel, minimize displacement and stress caused by environmental burden, such as earthquakes and hydrodynamic loads that can become severe in the case of sea crossings with SFT system [2].

The stability of the structure of the Submerged Floating Tunnel (SFT) is secured by the anchoring system (mooring system) is adequate, which is made from a steel cable that is at a depth remains on the seabed and connected to the tunnel by means of a ball hinge. Thus, the effect of the configuration of the cable on the structural behavior should be evaluated on the basis of the results of the dynamic analysis [3]. So to reduce the instability of the structure of Submerged Floating Tunnel (SFT) was added to the mooring system with the selected configuration.

A. Structure Cabling System of SFT

The cable system also plays a role in order to inhibit the tunnel, to minimize displacement and stress caused by environmental burden, such as seismic actions and hydrodynamics (Mazzola ni, 2009). Cable system for SFT system is understood up to now not included in the typology used for traditional cable-stayed bridge, because it consists of a group of wires, placed along the tunnel with or among a particular axis, which connects directly to the seabed tunnel. Each cable system will be subjected to tensile force due to buoyancy residual (residual buoyancy), traffi c loads and its own weight, alleviated by the buoyancy, and anchore d to the seabed through the foundation of the cable group of it [1].

B. Configuration Cable SFT

The case studies were considered long-junction (L) 150 m long 80 m is assumed flat in the middle of the intersection and inclined along the 35-m on either side edges. The depth of the sea floor is set at 21 m, the average water depth archipelago junction (Figure 1). The tunnel was submerged 5-m below the water level and the relationship between the SFT and beaches are set joints. SFT cross section consists of a steel frame and plate as shown in Figure 1 [6].

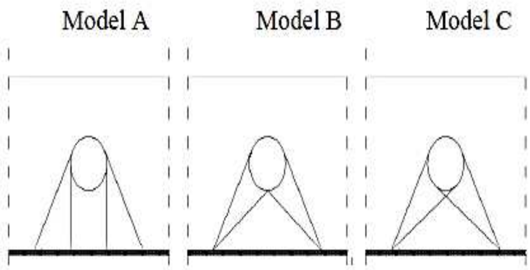

Figure 1. Configuration Cable Group of SFT

II. METHODS

A. Preparation

Modeling is divided into various conditions that one condition is used as a parameter modeling. Prototype modeling plan co nfiguration according to Table 1. The table is taken from one of the variables configuration. The following configurations are studied in particular for the analysis inclination angle position cable with various configurations based on the testing of test models.

Table 1 Configuration Modeling Structure S FT

5	SIK	9	1.2	1.5	A	S-S	0.65
		9	1.2	1.5	B	S-S	0.65
		9	1.2	1.5	C	S-S	0.65
		9	1.2	1.5	D	S-S	0.65
		9	1.2	1.5	E	S-S	0.65
		9	1.2	1.5	F	S-S	0.65
		9	1.2	1.5	G	S-S	0.65

Description:

- SIK = Angle of Inclination
- Hs = Wave Height
- Ts = Wave Period

In the form of a
numerical modeling analysis using SAP200 0 aid program. Here the
data structure SFT planned according to Table 2:

Table 2 Size SFT prototype

Magnitude	Prototype	Units
overall length,L	150	m
Diameter of SFT,D	5	m
Massa of SFT,m	2834	ton
buoyancy,B	1523	ton

The environmental data from the thousand islands that will be used in planning an effective configuration for SFT structure is as follows on table 3:

Table 3 SFT prototype size

Fluid dynamic environmental	Symbol	Unit	Value	Structural Property	Symbol	Unit	Value
Fluid density	ρ	kg/m^3	1,025	Tunnel equivalent density	ρT	kg/m^3	2,018
Water depth	h	m	20	Tunnel outer diameter	D	m	5.5
Wave height	H	m	1.2	Tunnel inner diameter	d	m	4.7
Wave period	T	m	3.58	Tunnel eauivalent Young	ET	N/m^2	3.2×10^{10}
Surface current velocity	UO	m/s	1.2	Cable density	ρC	kg/m^3	7,850
Drag coefficient	CD	1	1	Cable diameter	dC	m	0.1
Mass/inertia coefficient	Cm	1	2	Cable young modulus	EC	N/m^2	1.4×10^{11}
Added-mass coefficient	Ca	1	1	Kinetic viscosity coefficient	U	m^2/s	1.067×10^{-6}

In a study in the Thousand Islands, the force uplift is 31563.5 KN and total structur al weight is 25 770 KN, so that the ratio of the power lift and the weight of the structure is 1.22. This ratio will meet the criteria, ie between 1.2 to 1.3. So the size of the cross-sectional structure of SFT with 5m diameter steel material with 101.7mm sling is used as the study of this SFT. For the analysis of the structure, the model Finite Element (FE) of this structure created using Abaqus 10.4.

B. Planning

Other supporting data for this study based on data compiled prototype that has been analyzed previously. The cross-section of data Beikut scaled test model structure based on the prototype (Fig.2 and Fig.3).

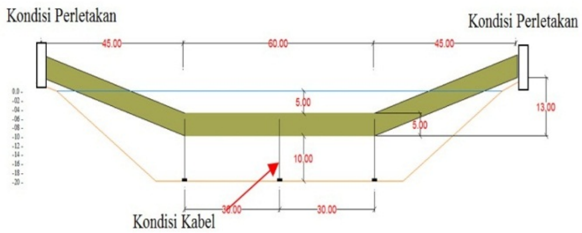

Figure 2. Model Test The scaled

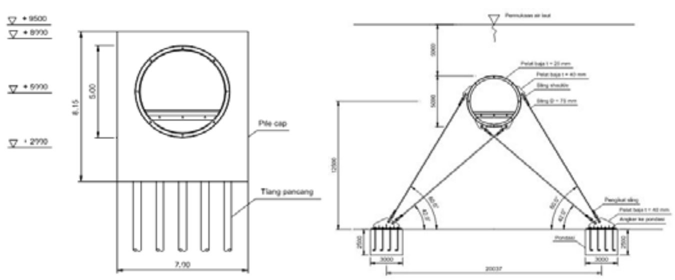

Figure 3. Pieces SFT

C. Structure Modeling Configuration Cable SFT

In the early design prototypes of five different cable configurations on previous research, has analyzed and evaluated the behavior of the cable configuration caused by vertical and horizontal load by means of equivalent static analysis and then compared. On the basis of the results achieved, three cable configurations are shown in Figure 2.6 have been. Configuration analysis of the results of the physical predictions, shows that, very effective vertical cables for receiving vertical loads only, whereas self-defense in the horizontal direction is ignored. Cables tend to be very effective, both in vertical and horizontal directions, only if the four-wire configuration W shape (Fig.4), while the two inclination of cable has a condition defense is not very effective in both vertical and horizontal direction and they give rise to tension torque is relevant in the tunnel, when experienced a horizontal action.

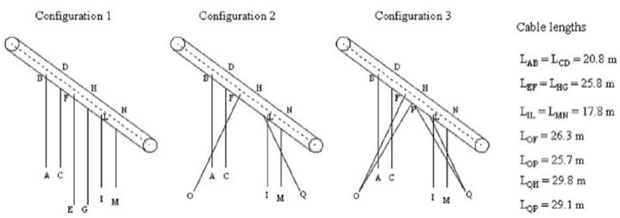

Figure 4. Configuration Cable Prototype SFT

III. RESULTS AND DISCUSSION

By using the auxiliary program Abaqus finite element 10.4, modeling mooring system saddled with the burden of displacement gradually from 0.001 to 0.005 mm in Figure 5.

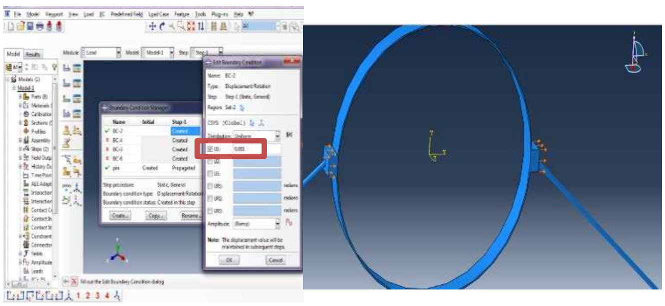

Figure 5. Imposition of Displacement On SFT Structure

Imposition of displacement only modeled in one direction only, namely the direction of x it can be seen in Figure 5. After loading and subsequent meshing running SFT where available stress and the displacement value (Fig.6).

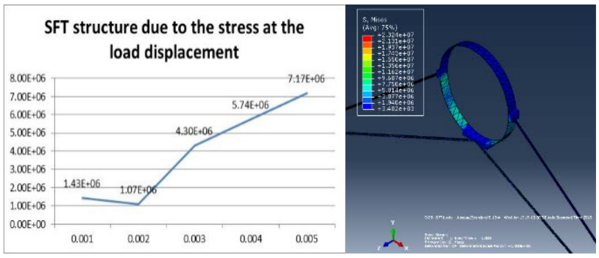

Figure 6. The stress On SFT Structure due to loading displacement

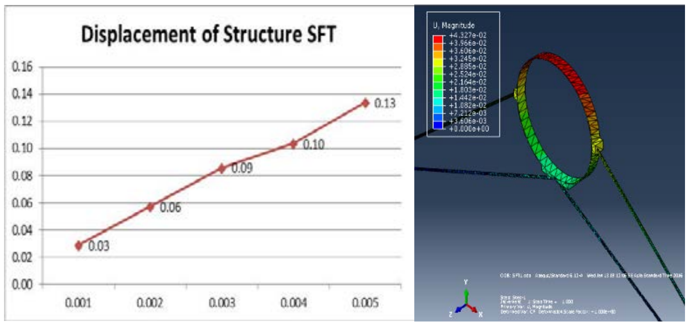

Figure 7. The Displacement On SFT Structure

IV. CONCLUSIONS

1. In the mooring system modeling over voltage generating value and good reaction. It can be seen in ABAQUS 10.4 modeling results with given load displacement gradual ly.
2. Transfer of the structure due to load displacement that occurs relatively small it can be seen in the difference perpidahan range from approximately 30 cm.

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