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## Comparative Analysis on Stress State of Submerged Floating Tunnels in Different Anchor Cable Arrangement Modes

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### Abstract

Compared with submerged floating tunnels with other supporting systems, anchor cable type submerged floating tunnel is characterized by flexible structure arrangement, wide applicability and economical advantage. However, the mechanical features are obviously different under different anchor cable arrangement modes. By numerical calculation, structural displacement, bending moment and strength and distribution characteristics of axial force of anchor cable under the action of static load, wave load and water flow load are comparatively analyzed and applicable scopes of different anchor cable arrangement modes are given.

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**Keywords:** submerged floating tunnel; anchor cable; arrangement mode; comparison

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### 1. Introduction

According to incomplete statistics, China has built (including under construction) more than 30 cross sea (cross river) tunnels, such as Qingdao Jiaozhou Bay Subsea Tunnel, .Xiangnan Xiamen Subsea Tunnel, Hong Kong Hongkan Cross Harbor Tunnel, Wuhan Yangtze River Tunnel, Nanjing Yangtze River Tunnel, Shanghai Yangtze River Tunnel, Hong Kong-Zhuhai-Macao Bridge Subsea Tunnel, etc [1]. Those tunnels adopt many construction methods, such as drilling-blasting method, shield method and immersed tube method. It can be said that China has basically mastered key technology of construction method of above mentioned subsea tunnels. However, follow-up construction of China's cross sea tunnel will face more complicated water environment, such as planned key engineering cross Qiongzhou Straits, Bohai Straits and Taiwan Straits. The traditional methods have been unable to

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meet demand of construction. In order to adapt to complex submarine topography and geological conditions, submerged floating tunnel has gradually become a new field of research.

Submerged floating tunnel (SFT) is a kind of traffic structure which passes across straits, large lakes and other waters and is composed of main body structure and supporting system which are submerged in water [2]. Compared with tunnels constructed by other methods, the biggest difference is the surrounding medium. Surrounding medium of submerged floating tunnel is seawater. According to floating depth, wave and water flow load, support system can be divided into anchor cable, floating drum and pile type [3], as shown in Fig. 1.

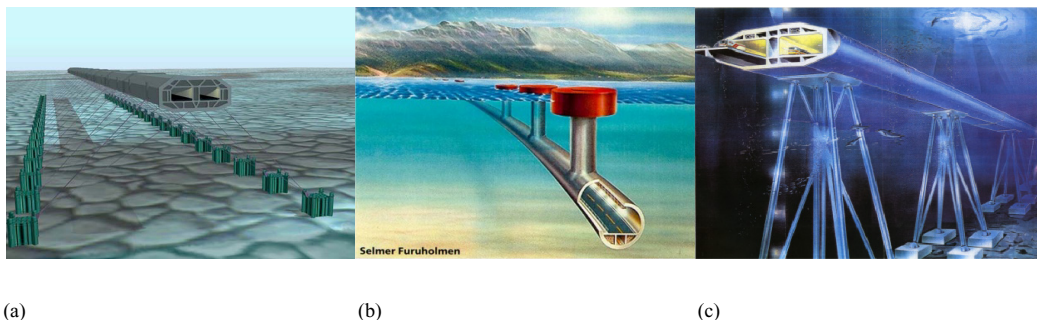


Fig. 1 Supporting modes of submerged floating tunnel: (a) Anchor cable; (b) Floating drum; (c) Pile

Anchor cable submerged floating tunnel is characterized by flexible structure, wide application and economical advantage. Arrangement modes of anchor cable are diversified, such as vertical arrangement, inclined arrangement and mixed arrangement. Different arrangement modes greatly influence the stress characteristics of main body structure [4,5]. In this manuscript, value calculation analysis is adopted.

**2. Calculation model**

The submerged floating tunnel is put in water at certain depth, is fixed with the seabed by anchor cable. Its structure drawing and calculation model are shown in Fig. 2.

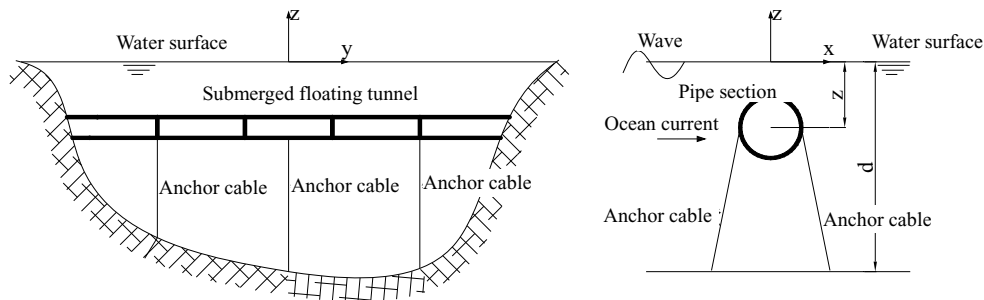


Fig. 2 Structure drawing and calculation model of submerged floating tunnel

The submerged floating tunnel bears dead load, wave load, water flow load, etc [6]. And the calculation of wave load is most critical. In this paper, it is calculated based on Morison equation [7-9].

$$F_H = F_{DH} + F_{IH} \tag{1}$$

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