

2nd International Symposium on Submerged Floating Tunnels and Underwater Tunnel Structures

Enlightenment to floating tunnel of existing typical submerged tunnel

Ding Hao^{a,b,*}, Li Qinxi^{b,c}, Jiang Shuping^b, Li Ke^{a,b}

^aChina Merchants Chongqing Communications Technology Research & Design Institute Co., Ltd., Chongqing 400067, china;

^bNational Engineering Laboratory for Highway Tunnel Construction Technology, Chongqing 400067, china;

^cCollege of Civil Engineering, Chongqing Jiaotong University, Chongqing 400074, china

Abstract

Currently, submerged floating tunnel still stays in scientific research stage, while many submerged tunnels have been built by use of borehole-blasting method, shield method, immersed tube method and other traditional construction methods. This paper, through wide literature research and engineering data collection, analyzes construction environment limits and typical operating diseases of submerged tunnels for various traditional construction methods, and, specific to the eight typical major water areas including Taiwan Strait, Qiongzhou Strait, Bohai Strait, Bering Strait, and Messina Strait, discusses and analyzes enlightenment to floating tunnel project of existing submerged tunnel: (1) For submerged tunnels using traditional construction method, only from the point of view of construction environment limits, existing construction experience and technology have already been not suitable for 50~87.5% of typical major water areas, technical breakthrough or innovation is required, while floating tunnel will be one of the effective options for these water areas. (2) For construction of submerged tunnels in part of major water area, combination of traditional construction method+floating method will be one effective method. (3) Water leakage, lining material degradation and rebar corrosion and expansion and other diseases and specific difficulties in maintainability and durability of structure and connection components for submerged tunnels using traditional construction method will be main operating diseases for floating tunnel.

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Peer-review under responsibility of the organizing committee of SUFTUS-2016

Keywords: floating tunnel; submerged tunnel; strait; disease; operation

* Corresponding author. Tel.: +86-18008377617; fax: +86-23-62653128.

E-mail address: dinghao@cmhk.com

1. Introduction

Building history of submerged tunnels may date back to submerged pedestrian tunnel at the Thames, England in 1843. Structural styles of submerged tunnel are dominated by deep-buried and underground-excavated tunnel and immersed tube tunnel, mainly including submerged borehole-blasting tunnel, submerged shield tunnel and immersed tube tunnel, etc.. In 1989, International Tunneling Association SFT (Submerged Floating tunnel) working team officially launched floating tunnel special study[1], and such tunnel became one brand new conceptual structure of submerged tunnel crossing deep sea areas. Various countries in the world have carried out a lot of studies[2] on floating tunnel over more than 20 years, Norway, Italy, and China etc. even have announced construction plans for floating tunnel, but none has been put into practice finally. At present, floating tunnel still stays in scientific study stage as a whole, having a great distance from engineering implementation. In contrast, on one side, construction of submerged tunnel using traditional construction methods are in full swing, while on the other side, construction and operation of these submerged tunnels reveals many environmental limits of traditional construction methods and presents some defective diseases, attracting reflection on submerged tunnels[3~8] and careful rethought of enlightenment to construction of future floating tunnels[9~10]. Therefore, it is necessary to discuss enlightenment to floating tunnel projects of existing submerged tunnel from aspects of construction experience and level and later management and maintenance problems.

2. Construction environment limits of existing submerged tunnel

See Table 1 for existing typical borehole-blasting submerged tunnels at home and abroad by far. Wherein, the longest submerged tunnel is Japan Seikan Tunnel, 54km long, which also has the largest burial depth and water depth among similar projects, respectively 100m and 140m. The longest submerged highway tunnel is Jiaozhou Bay Subsea Tunnel in Qingdao, 6.2km long, burial depth and maximum water depth of which are respectively of 70m and 40m, both of which are also largest in similar tunnels.

Table 1 Several comparisons of typical submerged borehole-blasting tunnels

Tunnel	Geology	Length	Burial depth	Maximum water depth	Purpose	Construction method
Japan New Kanmon Subsea Tunnel	Volcanic geology	18.77 km	66 m	20 m	Railway	Borehole-blasting method
Japan Seikan Tunnel	13 kinds of different geologic structures and many faults	54 km	100 m	140 m	Railway	Borehole-blasting method
Xiang'an Subsea Tunnel in Xiamen	Granite formation, micro aquifer	5.9 km	70 m	35 m	Highway	Borehole-blasting method
Jiaozhou Bay Subsea Tunnel in Qingdao	Complete granite formation	6.2 km	70 m	40 m	Highway	Borehole-blasting method

Table 2 lists out typical submerged shield tunnel. Wherein, Channel Tunnel is the longest among all submerged railway tunnels, which is 50 km long, with maximum water depth and burial depth respectively of 60m and 100m. In China, Chongming River-crossing Tunnel in Shanghai is the shield tunnel having largest diameter of 15.2 m; Weisan Road River-crossing Tunnel in Nanjing has the largest water depth of 72 m.

Table 2 Several comparisons of typical submerged shield tunnels

Tunnel	Geology	Length	Burial depth	Maximum water depth	Purpose	Construction method
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