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厦门海底隧道地层变形监测与机制分析

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摘要 厦门海底隧道施工过程中，工程技术人员将临着陆域段地层大变形、砂层施工控制、全风化花岗岩地层变形机制以及如何穿越结构交界面和全(强)风化深槽(囊)等诸多难题，这些都迫切需要深入研究海底隧道上覆地层的变形规律以及地层变形发展的机制和控制技术。通过陆域段地层变形实测以及对隧道施工过程进行三维流固耦合数值模拟分析，较好地反应了地层变形的分布、发展规律，地下水的运行、作用机制，以及地层大变形发生的力学原因。同时，也较好地描述了海底隧道中围岩－衬砌结构－超前支护－注浆加固－地下水，这一结构体系在地层变形中的相互影响和相互作用。研究结果可为海底隧道陆域段顺利施工提供了技术参考和安全保障，也为即将通过海域软弱风化深槽作研究准备。研究结果表明，考虑流固耦合作用的数值模拟结果与现场监测、观测结果具有良好的一致性，进一步说明围岩、地下水以及相应的施工控制是海底隧道的三大核心技术要素。

关键词 海底隧道；数值模拟；变形监测；流固耦合

分类号

STRATUM DEFORMATION MONITORING AND MECHANISM ANALYSIS OF XIAMEN SUBSEA TUNNEL

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Abstract

Xiamen subsea tunnel is the first subsea tunnel in China. During its excavation process，engineers are faced with many technical difficulties，especially the large deformation of stratum，the controlling methods of sand layer and complete weathered granite. In addition，the issues that how to go through the weak structure interface， complete weathered deep valley or capsule during construction are specially considered；all these issues urgently need the understanding of the deformation law of tunnel for upper strata；and the controlling measures of the large deformation should be taken. Combining the three-dimensional numerical modeling of fluid-solid coupling，it is shown by the in-situ deformation monitoring that how the stratum subsidence is distributed and developed with time and space，and that how groundwater transports and works. Meanwhile，mutual influences and interaction of surrounding rock-lining-presupporting-pregrouting-water structure system can be well modeled and explained. The research results agree well with the results of field test of weak deep-sea valley. It is also further verified that surrounding rock，lining，as well as construction controlling techniques are the key factors in subsea tunneling.

Key words subsea tunnel；numerical simulation；deformation monitoring；fluid-solid coupling

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