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论文

救生舱板壳结构抗冲击结构安全分析及优化对策

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摘要：

为获得强度高、质量小、容积合格的救生舱板壳结构，在静力学分析的基础上，结合钢制压力容器标准，确定板壳结构的基本尺寸。然后，考虑板壳结构可能出现的失效形式，设计了4种尺寸详细的板壳结构，包括内部焊接扁钢、矩形管、外部焊接扁钢、外矩形。利用动力学有限元方法，进行了板壳结构抗爆炸载荷模拟，计算结果显示几种板壳结构位移均低于20 mm，最大应力均不超出强度极限，证明均未发生变形失效或破坏失效，结构可靠。薄弱环节出现在中舱段中间位置、端面壳体中间位置及加强筋中间位置及拐角焊接处。根据仿真数据，分析几种加强筋提高壳体强度、刚度的能力，得出小型舱可在壳体外部焊接矩形管，中型舱可在内部焊接纵向起筋的扁钢，大型舱可在外部焊接矩形管加强筋的同时内部焊接扁钢加强筋的结论。模拟结果与文献的实验结果吻合，验证了所用模拟方法的有效性。对薄弱环节进行局部加强，提高板壳结构的抗冲击性能。

关键词： 煤矿井下；救生舱；板壳设计；结构安全分析；冲击波

Structure safety analysis and optimization of refuge chamber shell under explosion load

Abstract:

In order to obtain refuge chamber shell structures with the requirements of high strength，low weight，and enough volume，the basic dimensions of the shell structure were first determined on the basis of statics analysis and steel pressure vessel standards.Following that，four shell structures with detailed dimensions reinforcing rib were designed，including shell with internal steel，internal rectangular tubes，external steel，and external rectangular tube to prevent failure.The explicit nonlinear dynamic analysis program was used to simulate the response of the four types.A shock wave of 300 ms duration and 1.0 MPa at its highest value was applied to the shell.The maximum displacement was less than 20 mm，located in the central part of sides and the outer space of portals.The maximum stress was below the strength limit，located in an intermediate position and on the corner of reinforcing rib.The calculations indicated that none of the four structures demonstrated deformation failure or strength failure.This shows they are able to meet safety requirements.Simulations were conducted to verify the results.The situation suitable for each shell structure was demonstrated in the simulation results.A small cabin might be built with the external rectangular tube，and a medium sized cabin with internal steel.Large cabins may be constructed using internal steel and the external rectangular tube.The impact performance of the shell structure can be optimized if the weak link is locally strengthened.

Keywords: deep shaft；refuge chamber；shell structure design；structure safety analysis；shock wave

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