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学术论文

深圳大运中心体育场钢屋盖结构设计若干关键技术研究

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摘要：

深圳大运中心体育场钢屋盖采用单层折面空间网格结构。80多吨的超大铸钢节点密切结合铸造工艺特点，通过有限元计算分析和节点构造等的优化提高节点质量。对碗盖球的铸钢球铰支座进行包括接触的弹性和弹塑性有限元分析，提出了简化接触边界条件的弹性阶段实用计算方法，采取了支座充分转动和防脱臼措施。对钢板热成型圆管进行了材质比较、成型后产品检验。分析表明：超大铸钢节点安全可靠；球铰支座极限荷载达到设计荷载的3.1倍，支座上部碗体壳局部接触区域存在三向拉力场，下部实心半球局部承压区域呈三向受压状态。预留凹槽、空隙可实现支座充分转动，设置裙边、穿心锚栓可防止意外脱臼的发生；内径与壁厚比值小于20圆管可采用热成型，钢板宜优先采用高效的Q345GJ钢，成品经检测各项指标均满足或高于国家标准要求。

关键词： 单层折面空间网格结构 超大铸钢节点 碗盖球的球铰支座 有限元分析 力学性能

Research on several key technologies for structural design of steel-roof of the Shenzhen Universiade Sports Centre

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Abstract:

A new type of structural system named as single-layer folded-plane latticed shell structure was adopted for the steel roof of main stadium of the Shenzhen Universiade Sports Center. Although there are over 80 tons of massive cast-steel nodes, its good quality is assured since the design was based on finite element analysis and optimization of the joint structure. Both elastic finite element analysis and elasto-plastic finite element analysis on the cast steel spherical joint supports were conducted. This paper proposes a very practical calculation method for the elastic stage by simplifying the contact boundary. For the calculation, it is necessary to ensure a full rotation of the support and take anti-separation measures. Moreover, material comparison among hot-formed steel pipes and inspections to the finished products need to be conducted. From the analysis, it is believed that massive cast-steel nodes are safe and reliable. The ultimate load carrying capacity of the spherical joint support reaches 3.1 time of the design capacity. In the bowl-shell, there are three directional tension fields. The lower part of the hollow ball partially bears the stress in three directions. To fully rotate the support, concave-slots and gaps need to be reserved beforehand. To avoid the occurrence of accidental separation, an apron and center-hole anchor bolts need to be used. In the case that the ratio of inner radius to the wall thickness is 20, a hot-formed steel pipe can be adopted. The Q345GJ steel is preferentially used for the steel plate. According to the inspection results, the indices of the product satisfy the requirements of national standards.

Keywords: single-layer folded-plane latticed shell structure massive cast-steel node spherical joint support of a bowl-capped ball FEA mechanical performance

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