

学术论文

深圳大运中心体育场空间钢结构杆件计算长度研究

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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。由三角形平面以各种倾斜弯折组成, 且该平面内设置小三角形网格, 由焊接组合箱形断面的次杆件连接在面面交线的四分点。位于面面交线的主杆件稳定受到两端边界条件、面内次杆件、面面夹角的角度等诸多因素影响。目前规范还没有对该类复杂边界条件杆件计算长度的规定。根据变轴力两端铰接的稳定承载力计算式, 以线性稳定分析杆件失稳模态为基础, 进行几何非线性稳定整体分析, 考虑了临界状态相邻杆件的变形及非线性变形影响, 分析了杆件临界失稳模态以及杆件轴力变化, 获得临界承载力。根据变轴力稳定计算式, 得到该杆件的计算长度。分析表明: 主杆件计算长度系数受三角形折面夹角和两端节点刚度影响较大; 大部分主杆件计算长度系数小于或接近1.0, 立面铅直杆件受水平位移影响, 其计算长度系数大于1.0。主体结构卸荷和整体稳定分析验证了计算长度取值的合理性。

关键词: 单层折面空间网格结构 非线性稳定分析 变轴力 计算长度 临界承载力

Research on effective length of bar of space steel structure of the Shenzhen Universiade Sports Center

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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 the main stadium of the Shenzhen Universiade Sports Center. The whole structure was composed of numerous triangle grids bent in different angles with subordinate triangle grids inside. The subordinate triangle grids were connected to the quarter point of the intersecting line of two surfaces by the subordinate bar of the welded combined box section. The stability of the major bar in the intersecting line was affected by many factors, such as the border, the subordinate bar in the surface, and the angle between the two surfaces. Currently, there is no code specifying the calculation of the effective length of the major bar. In order to calculate the effective length of the major bar, the instability model of the structure by linear method was analyzed first. Second, based on the results from the linear analysis, the instability model of the structure was analyzed with geometric nonlinear method. Then the critical loading capacity of the major bar was obtained. At this step, the effect of nonlinear deformation of adjoining bars was considered. Third, the effective length of the major bar was calculated according to the formula of instability capacity of varied-axial-force bar with pinned joint. The research shows that: 1) the effective length of the major bar is greatly affected by the angle between two surfaces and the stiffness of the two ends; 2) the coefficient of the effective length of most major bars is less than 1.0 or close to 1.0; 3) the coefficient of the effective length of vertical bar is more than 1.0 due to the influence of horizontal displacement. Both the unloading test of the main stadium and the overall stability analysis justified the research results.

Keywords:

single-layer folded-plane latticed shell structure nonlinear analysis of stability varied-axial-force effective length critical load carrying capacity

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